(Established 1832).

# AMERICAN ENGINEER AND RAILROAD JOURNAL.

PUBLISHED MONTHLY

BY

**R. M. VAN ARSDALE**

**140 NASSAU STREET, NEW YORK**

J. S. BONSALL,
Business Manager.

R. V. WRIGHT, E. A. AVERILL, Editors.

SEPTEMBER, 1908.

**Subscriptions.**—*$2.00 a year for the United States and Canada; $2.50 a year to Foreign Countries embraced in the Universal Postal Union. Remit by Express Money Order, Draft or Post Office Order. Subscription for this paper will be received and copies kept for sale by the Post Office News Co., 217 Dearborn St., Chicago, Ill. Damrell & Upham, 283 Washington St., Boston, Mass. Philip Roeder, 307 North Fourth St., St. Louis, Mo. R. S. Davis & Co., 346 Fifth Ave., Pittsburg, Pa. Century News Co., 6 Third St., S. Minneapolis, Minn. W. Dawson & Sons, Ltd., Cannon St., Bream's Buildings, London, E. C., England.*

**Advertisements.**—*Nothing will be inserted in this journal for pay,* EXCEPT IN THE ADVERTISING PAGES. *The reading pages will contain only such matter as we consider of interest to our readers.*

**Contributions.**—*Articles relating to Motive Power Department problems, including the design, construction, maintenance and operation of rolling stock, also of shops and roundhouses and their equipment are desired. Also early notices of official changes, and additions of new equipment for the road or the shop, by purchase or construction.*

## CONTENTS



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The column entitled "What the Railroad Clubs Will Do in September," on page 369 of this issue, is intended not only to direct special attention to the work which these clubs are doing, but to assist our readers in getting into closer touch and making better use of them. With the co-operation of the club officers we believe that this column can be made of sufficient interest and value to warrant its appearance each month. We shall appreciate any expressions from our readers as to the advisability of continuing it, or of its value to them.

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they were afraid of getting the water too warm and stopping the injectors from working, the device was not used as much as it should be and gradually fell into disuse on the roads upon which it had been adopted. Attempts have been made to provide an automatic arrangement to divert the exhaust from the tank after the temperature had reached a certain height, but unfortunately these have apparently never been a success.

On the above-mentioned road the average temperature of feed water on the various divisions, and for the entire year, is in the neighborhood of 55 degrees, or 45 degrees lower than the temperature at which it can safely be put into the injector. Assuming that the steam delivered to the air pump and exhausted into the tank has dropped from 1,200 to 1,000 heat units by the time it reaches the tank, which allows for the loss of heat during condensation and the work done in the air pump, it is estimated that an average saving of 2½ per cent. could be made by the intelligent use of the air pump exhaust, taking into consideration that a large amount of the water would enter the injector before the temperature had been brought up to the limit of 100 degrees. It would seem as if the savings to be effected in this direction were sufficient to warrant the expenditure of considerable energy to develop some satisfactory means of utilizing this waste steam.

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The following question was recently submitted to us: "The mechanical department judges the condition of power with respect to how soon back shop repairs will be needed on it. The operating department judges the condition of power with respect to its ability to move trains at the instant called for by them. A master mechanic may have his power in good condition, as far as the back shop is concerned, yet have a large percentage tied up waiting for minor roundhouse work. One man says the power is in good condition, the other says it is rotten. Who is right?"

The most reasonable answer would seem to be that the two departments should get together on some common basis of comparison. As a matter of fact, neither one of the two departments is an end in itself, but they should work together for one common object, i. e., good service to the patrons of the road and the largest possible earnings consistent with this. Results are what are wanted, and the maximum efficiency of the organization can only be secured by having the hearty cooperation of the different departments and by, as far as possible, eliminating all unprofitable discussion. If power is not available when it is wanted it would seem that its condition for the time being was poor and the aim should be to prevent this from happening as much as possible. Power is often needlessly placed temporarily in bad condition due to the lack of foresight and cooperation on the part of the operating department with the motive power department.

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The instructions issued by the executive committee of the Master Car Builders' Association, to govern the committees in the preparation of their reports for the 1909 meeting, will commend themselves to all who are interested in the work of that organization. They are reproduced on another page of this issue. The work of this association is becoming so important and has such far reaching effects that action on any subject should be taken only after mature deliberation. Placing the committee reports in the hands of the membership about May 1st will enable the officers of the different roads to discuss the matters carefully, not only with their assistants and subordinates, but with officers of such of the other departments as might be more or less affected by any action taken. At the convention they will then be in a better position to discuss the various questions intelligently and to protect the interests of the road with which they are connected. The thorough discussion which will result will enable the membership to vote more intelligently on such questions as may be submitted to letter ballot. The necessity of reading reports in full, which is usually a tiresome and unprofitable proceeding, can be done away with and it will be only necessary to open the discussion of each subject by presenting a brief abstract of the report. That the instructions promise to be effective is shown by the fact that several of the committees have already held meetings and taken the preliminary steps toward the preparation of their reports. It is to be hoped that the executive committee of the Master Mechanics' Association will take similar action.

In this connection it is important for the roads represented in the association to realize that it is to their best interest to have as large a representation as possible at the convention meetings. While questions of standards and recommended practice are submitted to letter ballot and each road has a certain number of votes, depending upon the amount of equipment which it operates, still the preliminary action leading up to this is decided by the majority vote of the members present at the meetings. A study of the roads represented at the Master Car Builders' Association meetings indicates that a few of the roads have apparently studied closely the effect which any action of the association on different subjects may have on their particular road. They apparently find it to their interest to have as large a representation as possible at the meetings and it is interesting to note the team work which often takes place in pushing and placing before the convention such matters as are apparently of special interest to some one of these roads. That other roads do not seem to realize the importance of this is indicated by the small representation for some of them, and the fact that apparently the members who are present have not studied the subject over together and outlined the policy which would give the best results for their particular road.

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## MOTOR CARS.

[*Editor's Note.—We were greatly pleased, shortly after the August issue was mailed, to receive letters from two prominent engineers, both of whom have devoted considerable study to the motor car question, congratulating us on the stand which we took in the editorial on "Motor Cars." The following letter was reecived just as we were about to go to press, otherwise we would have secured permission to print the other two letters in connection with it.*]

TO THE EDITOR:

In the AMERICAN ENGINEER AND RAILROAD JOURNAL for August, page 312, is an editorial criticising, in a general way, the development of the single unit motor car for railway purposes. It is stated that a number of cars have been built in this country and elsewhere, during the last few years, and proved failures from one cause and another. True, many of these cars, or rather the development, have been failures, from the fact that in many cases a very limited appropriation has been made to some railroad mechanical officer to build an experimental car; and, about the time the real work of the development was to commence, the small appropriation has been used up, and the work stopped.

The editorial states: "It is impossible to care for the former in the same place and manner as other motive power on the road is cared for." The railroads of the country have been working for from twenty-five to fifty years, developing terminal facilities for the economical handling of cars and locomotives; and, naturally, the installation of the service of motor cars, in connection with locomotive equipment, would cause some little confusion for a short time. Electric traction cars and automobiles are satisfactorily cared for in houses arranged with a view to their economical handling, and the fact that steam railroad terminal facilities are not entirely adequate to meet the requirement for economically handling single unit motor cars, is not a just criticism against the motor car as it stands to-day. In case of repairs, however, the entire car is naturally put out of commission. And, with the steam locomotive and train, we have the locomotive and one or possibly two coaches, any one of which may be put out of commission.

The cost of development of any piece of mechanism is very much greater than the selling price for the same article at a later date, when standards have been arrived at, and the cost of construction has been brought down to a minimum. Even as

a new development, the single unit motor car can be built to-day for very much less money than a small locomotive and coach. On a cost per pound basis, the motor car has very much in its favor. An objection is made to the necessity of carrying an extra unit to maintain service. There is probably no class of mechanism in the country to-day requiring more extra units than the steam locomotive. Traction lines figure on an extra unit for every four or five cars.

The objections to "a small, highly specialized locomotive, preferably of the 0-4-0 type, attached to a combination coach," are a higher cost of operation; higher first cost of equipment; necessity of say four men in place of two for the operation; and serious objection to the smoke and cinders from any steam locomotive, especially in interurban service, where so many stops are made. This last objection is met with in the case of a steam motor car burning coal; but, with the gasoline car or gasoline electric car, this very objectionable feature is done away with—making travel a pleasure rather than an irksome task.

C. B. SMITH, Asst. Mech. Engr.
Union Pacific Railroad Co., Omaha, Neb.

## FUEL ECOMOMY.

An interesting and valuable report on the question of smoke prevention and fuel economy was presented at the recent meeting of The Traveling Engineers' Association. The report was based largely on the replies to a series of questions which were submitted to the members and the following is an abstract of the most important parts of it.

A synopsis of the replies received, boiled down, results in the following conclusions: That fuel economy can only be effected through education; but that this education must not be confined to simply teaching the firemen how to fire or the engineer how to work his engine economically, but must extend from the bottom to the top, that is, from the man at the mines to the highest officer of the road, so that all will know and realize the importance of the subject and by their help and co-operation assist to bring about the desired results.

The efforts of the traveling engineer are confined principally to the men in the cab, and while very effective so far as they go, do not by any means accomplish all that could be done, were he granted full, absolute and extensive support. While granting that the traveling engineer is given a certain amount of support from the upper quarters, yet candor compels us to say that this support, except in a few notable instances, is of but an intermittent and perfunctory nature, and therefore as a whole not lasting and of little actual value. This, however, is not through any spirit of laxity or indifference on the part of the higher officials, but is brought about by conditions, and the fact that the average official on the American railroads is saddled with so many duties or has such an extensive territory that it becomes a hard matter to give each specific duty the attention that it deserves. With the mechanical man fuel economy is subordinated to maintenance of equipment and with the transportation man it is ranked by moving traffic, and, consequently, between the two the traveling engineer often fails to accomplish his ends simply for lack of proper support. Fuel economy and the results that can be obtained are of sufficient moment to warrant any railroad in putting on a special man to look after this one feature alone.

*Do firemen study?* The replies would indicate that firemen as a rule do not study to advantage. The free literature distributed by the various railroad companies on the subject of fuel economy is appreciated, but the men are more inclined to absorb the information through oral instructions and practical demonstrations. This, however, must not be taken as an argument against written or printed instructions. It simply proves the necessity of education along that line. The average fireman does not at first realize that he is simply an apprentice engineer and that when he reaches that position more will be required of him than simply 200 pounds of steam, and therefore does not care to puzzle his cranium with the problems of combustion, but takes his knowledge in the easiest form and less troublesome doses.

It has been noticed, however, that where firemen have through study mastered the principles of combustion they usually stand at the head of the list of firemen, and likewise after promotion to engineers they can do their work easier and better than their less educated brothers. The habit of applying brains to their work, formed when firing, remains to their after-advantage as engineers. As the future fireman will use his head as much as his back, we urge that all study be encouraged and to aid him to master what to many is a difficult lesson, that teachers or instructors or demonstrators (whatever you may call them) be employed to help the willing firemen over the rough places. The unwilling man has no place on an engine.

*Assistant road foremen.* We most emphatically advocate the employment of competent instructors, but would not call them traveling firemen, but assistant traveling engineers or assistant road foremen. They should have authority over the engineer as well as over the fireman, as without this authority, unless possessed of infinite tact, they might do more harm than good.

The assistant traveling engineer should be recruited from the ranks of engineers and should be a young, active and energetic man, one who can take the scoop when necessary and demonstrate to the fireman the correct way to handle it and get results —namely, the maximum amount of steam from the minimum amount of coal. In addition to being young and active and a first-class fireman, he should also be a first-class engineer, one who can, if necessary, demonstrate to the man on the right side of the engine how he can handle the engine to better advantage and, by so doing, help himself, the fireman and the company. This man would naturally fall in line for the position of traveling engineer when the latter is promoted. He should be subordinate to the traveling engineer and should either work directly under or else in harmony with him.

*Inspection of ash-pans, etc.* Most roads require this and all intelligent firemen naturally do it. A few trips with the air openings stopped up soon convinces the fireman of the advantage of keeping them open, and the lesson once learned is not soon forgotten.

*Instruction to fireman to keep the door closed, etc.* This is another lesson that is soon taught by a little experience, but it is always advisable to teach it direct, instead of letting the fireman find it out for himself, as the opening of the door and leaving it wide open while the engine is forced to the limit in lifting the train to speed, is apt to cause other damage: leaky flues, etc.

*When should grates be shaken?* This depends largely on local conditions, the nature of the coal, etc.; all are agreed, however, on the manner in which the grates should be shaken, namely by short, quick jerks, and not a slow, rocking motion. All are also practically unanimous that as a rule it is much better to shake the grates when the engine is drifting or working light than when being worked hard.

*Comparison of heating value of coal.* This is a refinement in comparison to men and engine efficiency that is practiced by but few roads. We recognize the fact that it is not always practical on all roads and, except for a basis of comparison, is unnecessary. We believe, however, that comparison should not be made between two different divisions, unless all conditions are exactly similar, not forgetting density of traffic.

The comparison should only be made between similar engines in the same class of service on the same divisions, but even that comparison cannot simply be made between passenger and freight, work and yard engines, on a ten-mile basis, with fairness, where regular engines are assigned to and kept, through and local passenger service, fast, slow and local freight, etc., as in that case, to be absolutely fair, comparison should be on a ten-mile-per-hour basis. Time is the one important consideration that is often lost sight of in making any comparison.

*Instruction of firemen on front end appliances, etc.* Too much information on any part of the locomotive cannot be given to the fireman or, for that matter, to any one else whose duties throw him in contact with engine service. Where it may not be practical to move a draft sheet up or down in order to give the fire-

man ocular demonstrations of its effect on the burning of the fire, yet the information to that effect and also the object of the different front end arrangements should be carefully explained, as the fireman knowing this can at once tell by the action of the draft on the fire if anything has become loosened or misplaced in the front end, in which case repairs can often be made before failure results.

*Premiums.* It is the sense of this Association that monetary premiums do not have the desired effects; in fact, quite the contrary seems to be the case, as it has been found to lead more toward sharp practice on the part of the men than actual economy, and consequently the company is little if any the gainer.

It is our opinion that it is more preferable to encourage a spirit of friendly rivalry among the men and to hold out advancement and promotion as a premium, instead of a small financial remuneration. We further believe that comparison between the efficiency of engines and men should be made on a ton-mile basis between those in absolutely similar service, and a monthly bulletin posted, showing the standing of different men. This bulletin can show the standing in dollars and cents, showing how much more one man cost the company to perform a certain amount of work than another. In addition to this bulletin, however, we favor giving letters of commendation to those at the head of the list, and friendly letters of admonition to those at the foot. If it is finally found that letters of admonition have no effect on the latter, it is well to drop them from the service, as it has been found that any man who cannot be reached through his pride cannot be reached in any other manner, consequently he is unfit for railroad service.

*Where firemen are obtained.* As one of our past presidents so aptly expressed it, "You would not hesitate to pick a $20.00 gold-piece out of the mud," so it makes little difference where you get your firemen, provided they are the right material. This is governed largely by local conditions and environment. My experience has been that the best men are recruited from the rural districts. As for early training, the common practice seems to be to let the applicant make student trips on freight engines, usually without pay, with experienced firemen and continue to make these trips until competent to go alone. This is usually a good tryout, as any man who will follow a modern engine for twenty or thirty days for nothing, in order to learn to fire, evidently wants the job and will no doubt stick.

*Student trips.* For examination, as mentioned above, student trips appear necessary, and there should be as many as required to win the approval of the traveling engineer or, in his absence, of three competent engineers with whom the applicant has made student trips.

Progressive examinations are heartily endorsed, as they appear to be the only way in which the majority can be induced to study and perfect themselves, and also a way of getting rid of undesirable men when conditions justify. In conclusion, we find the entire matter resolves into a campaign of education, and therefore everyone should be encouraged to acquire knowledge.

We must not forget, however, that as a fireman becomes better educated he becomes more observant and consequently we cannot with very good grace keep hammering him to save coal, etc., while at the same time we let him see that for each scoopful he saves on the road a ton is wasted about the roundhouse and coaling stations. He will be apt to say, "Why don't you practice what you preach?" showing that there are others who need education on fuel economy besides the fireman.

Above all, however, when you find an engine crew or, in fact, anyone trying hard to make a showing or a saving, don't forget to encourage them.

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RECORD IN TUNNEL DRIVING.—The contractor driving the tunnel at Taft, Mont., on the route of the Chicago, Milwaukee & St. Paul road's Pacific Coast extension, during the month of June pushed the bore 583 ft. deeper into the mountain. This is said to be a record. When completed the tunnel will be 8,571 ft. long. On August 1st it was 4,388 ft. long.

## MASTER CAR BUILDERS' ASSOCIATION COMMITTEES.

The executive committee of the Master Car Builders' Association is to be heartily congratulated upon the stand it has taken, as to the preparation of committee reports and the limitation as to the time of submitting them, as indicated by the circular recently issued by the secretary, Mr. Taylor. It is to be sincerely hoped that they will rigidly enforce these regulations.

This circular and the names of the chairmen of the various committees are as follows:

In order to expedite the work of the convention of 1909, the following instructions regarding the preparation and presentation of the reports of committees were adopted by the executive committee at a meeting held in Chicago, Ill., on July 15, 1908.

1. That all active, representative and associate members of the Association, immediately on receipt of this circular, transmit to the chairman of the respective committees all the information they may have on each subject, which they consider will be of assistance to the respective committees in preparing their reports.

2. That the chairmen of all standing and special committees prepare their circulars of inquiry and submit the same to the secretary for printing and issuing prior to September 1, 1908.

3. That prompt replies be made to the circulars of inquiry as issued by the different committees.

4. That the chairmen of all standing and special committees must have their reports in the office of the secretary not later than April 1, 1909, in order that the same can be printed and advance copies issued by May 1, 1909.

5. Committee reports which do not reach the secretary in time for printing and issuing by May 1, 1909, will be referred to the executive committee to decide whether the report shall be submitted to the convention.

6. That abstracts only of all reports of standing and special committees be read by the chairman of same before the convention, together with whatever additional data may have been accumulated after April 1, 1909, to the date of the convention.

7. That the members of standing and special committees who may individually or collectively submit a minority report, must prepare the same so that it can be issued with the report of the majority of the committee, and substituted for the majority report in the event the convention should so decide.

8. That each member of a standing or special committee sign either the majority or minority report.

### CHAIRMEN OF STANDING COMMITTEES.

*Arbitration.*—J. J. Hennessey, M.C.B., C., M. & St. P. Ry., West Milwaukee, Wis.

*Standards and Recommended Practice.*—T. S. Lloyd, S.M.P., D., L. & W. R. R., Scranton, Pa.

*Train Brake and Signal Equipment.*—A. J. Cota, M.M., C., B. & Q. R. R., Chicago, Ill.

*Brake-Shoe Tests.*—W. F. M. Goss, University of Illinois, Urbana, Ill.

*Coupler and Draft Equipment.*—R. N. Durborow, S.M.P., Pennsylvania R. R., Altoona, Pa.

*Rules for Loading Materials.*—A. Kearney, A.S.M.P., N. & W. Ry., Roanoke, Va.

*Car Wheels.*—William Garstang, S.M.P., C., C., C. & St. L. Ry., Indianapolis, Ind.

*Safety Appliances.*—C. A. Seley, M.E., C., R. I. & P. Ry., Chicago, Ill.

### CHAIRMEN OF SPECIAL COMMITTEES.

*Freight Car Trucks.*—A. Stewart, G.S.M.P., Southern Railway, Washington, D. C.

*Splicing Sills.*—R. E. Smith, G.S.M.P., A. C. L. R. R., Wilmington, N. C.

*Freight Car Repair Bills.*—J. F. Deems, G.S.M.P., N. Y. Central Lines, New York City, N. Y.

*Air-Brake Hose.*—LeGrand Parish, S.M.P., L. S. & M. S. Ry., Cleveland, Ohio.

*Side Bearings and Center Plates.*—R. D. Smith, A.S.M.P., B. & A. R. R., Boston, Mass.

*Painting Steel Cars.*—G. E. Carson, M.C.B., P. & L. E. R. R., McKees Rocks, Pa.

*Side and End Door Fixtures.*—C. S. Morse, M.C.B., W. & L. E. R. R., Toledo, Ohio.

*Tank Cars.*—A. W. Gibbs, G.S.M.P., P. R. R., Altoona, Pa.

*Train Pipe and Connections for Steam Heat.*—C. A. Schroyer, S.C.D., C. & N. W. Ry., Chicago, Ill.

*Classes of Cars.*—J. E. Muhlfeld, G.S.M.P., B. & O. R. R., Baltimore, Md.

*Salt Water Drippings from Refrigerator Cars.*—M. K. Barnum, Asst. to V.-P., C., B. & Q. R. R., Chicago, Ill.

*Revision of Constitution and By-Laws.*—D. F. Crawford, G.S.M.P., Pennsylvania Lines, Pittsburgh, Pa.

*Subjects.*—H. D. Taylor, S.M.P., P. & R. R. R., Reading, Pa.

*Arrangements.*—R. F. McKenna, G.F.C.D., D., L. & W. R. R., Scranton, Pa.

## SUCTION GAS PRODUCER POWER

By L. P. Tolman.

It is estimated that there are over 500 producer power plants in this country, having an aggregate of 150,000 horse power. Of these, about eighty-five per cent. are of the "suction" type and fifteen per cent. of the "pressure" type. The suction plants average approximately 100 horse power each, while pressure plants are usually built in sizes larger than 1000 horse power. This article deals with suction gas power plants in single units of 200 horse power, or smaller, and complete plants made up of a number of such units, 1000 horse power, or larger. This range of sizes covers the requirements of the great majority of power users.

### Comparative Waste with Steam and Producer Gas Power.

Fig 1 illustrates a modern steam plant with its many complications, including compound condensing steam engine with water tube boiler. This plant converts 8 per cent. of the total energy of the fuel into useful work (in actual practice the percentage utilized is usually less). In other words, 92 per cent. or more of the energy in the coal goes to waste as smoke exhaust from the engine, heat radiation, etc. A 150 horse power steam plant of this type, running at two-thirds load, 3100 hours per year, uses approximately 4½ pounds of coal per brake horse power per hour. With coal at $2.75 per ton, the fuel alone costs $1,918.12 per year. In addition, the cost of attendance is a large item of expense, and the boiler, especially, calls for constant attention, cleaning, and repairs.

The ordinary throttling governor steam engine with tubular boiler, a type which is in very general use, especially in sizes from 15 to 200 horse power, is shown in Fig. 2. This plant converts 5 per cent (though usually much less) of the total energy of the fuel into useful work. In small steam plants the total amount of energy utilized is often not over 2 or 3 per cent. In other words, 95 per cent. or more of the energy in the coal goes to waste as smoke exhaust from the engine, heat radiation, etc. A 150 horse power steam plant of this type, running at two-thirds load, 3100 hours per year, uses approximately 7 pounds of coal per brake horse power per hour. With coal at $2.75 per ton, the fuel alone costs $2,983.75 per year. In addition, it requires the entire time of at least one man to operate the plant. The boiler, especially, requires constant care, cleaning and repairs, and is always a source of danger.

A suction gas producer power plant is shown in Fig. 3. The apparatus is simple, reliable and very economical. With this plant 18 per cent. of the total energy of the fuel is converted into useful work (varies according to conditions, from 15 to 21½ per cent.). This means that a suction gas producer plant uses from one-half to one-fourth as much coal for a given amount of power as a steam plant. A 150 horse power suction producer plant, running two-thirds load, 3100 hours per year, uses approximately 1½ pounds of coal per brake horse power per hour. (Tests have been made showing a consumption of less than 1¼ pounds at two-thirds load and less than 1 pound at full load.) With anthracite at $5.00 per ton, the fuel alone costs $1,162.50 per year. Furthermore, the cost of attendance can be reduced materially with a producer plant, as the operator can spend part of his time in other useful work.

Much valuable information is given in the report of the United States Geological Survey concerning the fuel testing

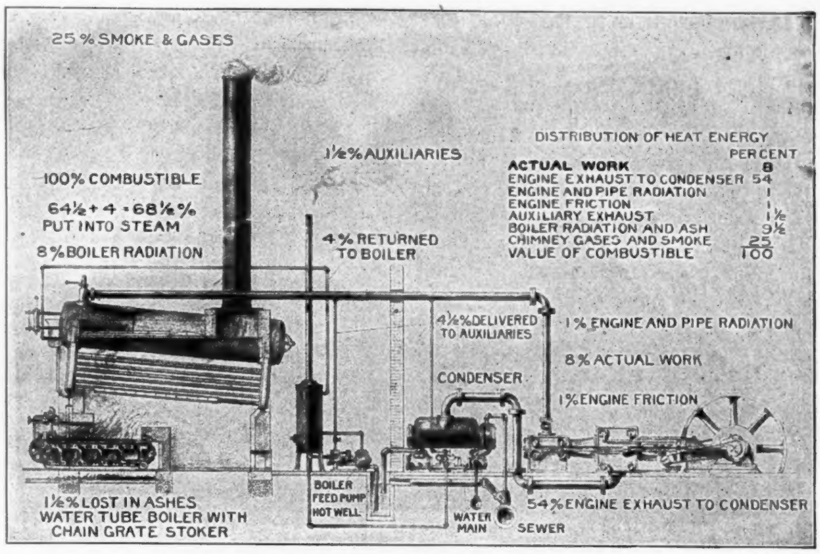



FIG. 1.—COMPOUND CONDENSING STEAM PLANT.

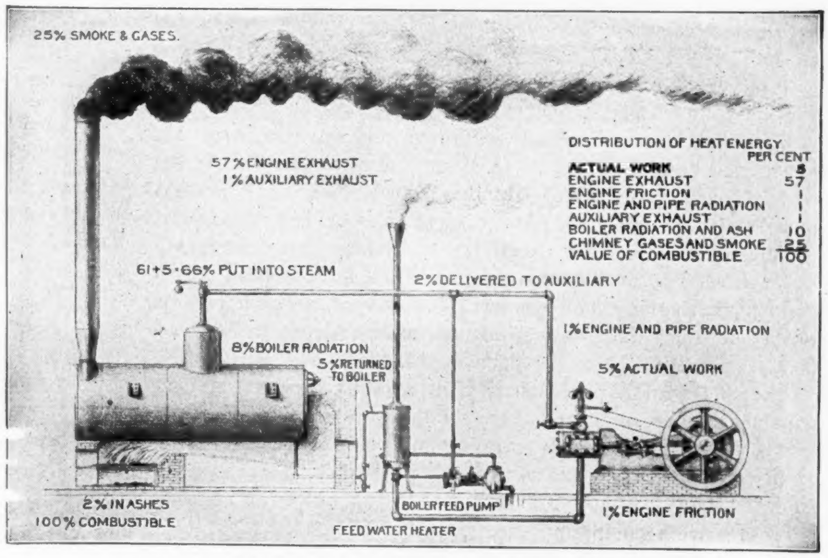



FIG. 2.—SIMPLE STEAM ENGINE AND TUBULAR BOILER.

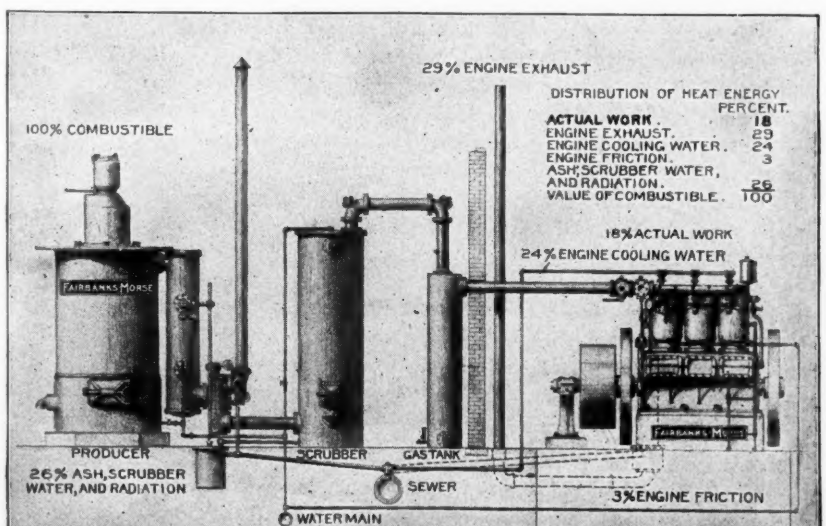



FIG. 3.—SUCTION GAS PRODUCER POWER PLANT.

plant at the Louisiana Purchase Exposition, St. Louis, Mo. For three years the Government experts conducted a series of tests on many samples of coal from mines all over the country. Briefly, the apparatus included a non-condensing Corliss engine steam plant with a water tube boiler and a pressure type producer with a three-cylinder vertical gas engine.

From the summary of results obtained from a long series of tests, the fuel consumption in the pressure type producer plant varied from 1.18 to 3.47 pounds per brake horse power per hour, the average being approximately 1¾ pounds. The average with the Corliss steam plant was found to be approximately 4½ pounds, using similar fuels. With lignite, the consumption in the pressure producer plant was from 1.95 to 3.47 pounds, the average of five samples actually figuring 2.60 pounds. With the Corliss steam plant using lignite, the average consumption of "coal as fired" (not "dry coal") was approximately 7 pounds.

While most of the above tests were on bituminous coals, which cannot be used advantageously in a suction producer, yet the consumption of anthracite in the latter is usually less than as stated for bituminous coal in the "pressure" type producer, probably due to the fact that there is less resistance to the flow of gas in the suction type. For example, tests on lignite in a suction producer commonly show a consumption of 2 to 2¼ pounds, whereas from the five lignite tests at St. Louis the average is 2.60 pounds in a pressure producer plant.

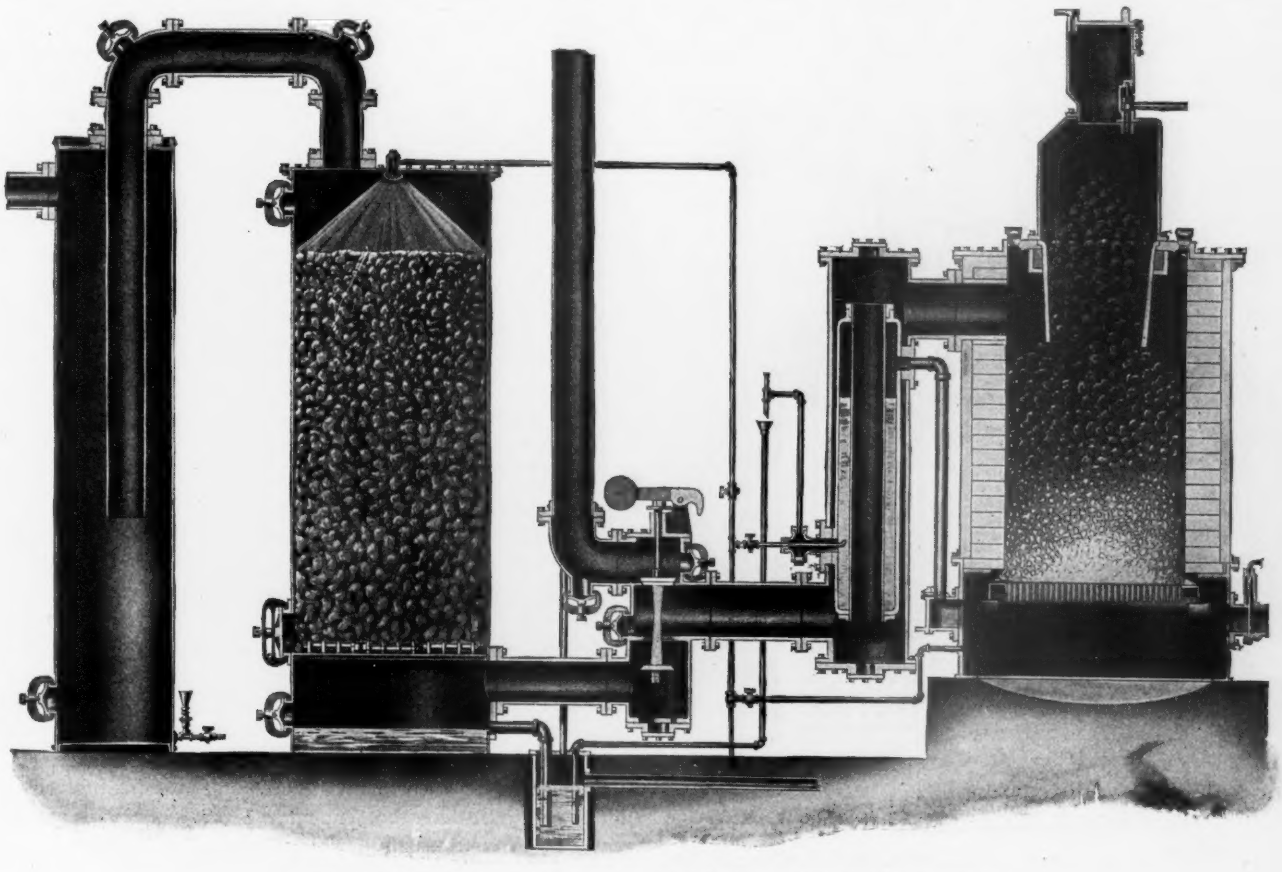


FIG. 4.—SECTIONAL VIEW OF FAIRBANKS-MORSE SUCTION GAS PRODUCER.

### Advantages of Suction Gas Producer Power.

We have already discussed the high thermal efficiency of the suction gas producer plant. The most important and the most practical commercial advantage is the economy effected in the cost of developing power. If there were no other advantages, this one feature would be sufficient reason for installing this system. Other advantages may be summed up briefly:

The producer, in which fuel gas is generated from coal, is almost as simple as an ordinary furnace for heating purposes. The gas engine is entirely automatic in operation and needs little more than the ordinary cleaning and care as to lubrication.

There is no danger from explosion or from fire. It is absolutely safe, even in the hands of men with little mechanical training, and the many plants which are in continuous operation, some of them twenty and even twenty-four hours a day, indicate that they are thoroughly reliable and will stand hard, everyday usage. Boiler insurance is unnecessary with producer plants and the troubles and dangers encountered with steam boilers are entirely avoided. The complete gas engine and suction producer plant is almost entirely automatic in operation, very little attention being required. Ordinarily the operator only needs to spend ten to fifteen minutes about every two hours to dump a few buckets of coal into the producer and give general attention to the plant. He can spend part of his time in other useful work and an extra man as fireman is not required, even with plants from 400 to 500 horse power.

Hundreds of thousands of dollars which are now spent annually in building smokestacks can be saved; and what is of greater importance, the smoke nuisance can be entirely abated.

Where the suction gas producer plant uses 1¼ or 1½ pounds of coal, the steam plant commonly requires 4 to 6 pounds, or more. Moreover, with the producer plant there are fewer ashes to be handled and disposed of.

The producer will hold fire all night or even for several days, and the proper quality of gas can be generated after fifteen or twenty minutes blowing to revive the fire. The engine can easily be started on compressed air.

The stand-over loss with the suction producer amounts to about one-third as much as with a steam boiler. In other words, where the stand-over loss with a steam plant for fourteen hours amounts to 600 to 800 pounds, or more, with a suction producer plant of the same horse power this loss would not exceed 200 pounds.

### Suction Gas Producers.

A sectional view of a Fairbanks-Morse anthracite suction gas producer is shown in Fig. 4. Coal is admitted to the producer through a hopper at the top. This has double closure, so that the fuel can be introduced without at the same time admitting air. In the process of partial combustion which takes place producer gas is generated. The hot gas passes through a vaporizer in which a small amount of steam is formed, which, with a limited amount of air, passes under the grate of the producer. In

the smaller sizes, the vaporizer is at the top of the producer, where it uses the waste heat from the escaping gas and where at the same time the water keeps the top from getting too hot. In the larger sizes the vaporizer is separate and connected to the producer by piping. From the vaporizer, the hot gas flows through the scrubber, which is merely a cylindrical-shaped tank filled with coke, over which a spray of water is constantly sprinkled. The large contact surface of the coke effectually cleanses the gas of dust and impurities carried over from the producer, and also acts to cool the gas, which is essential in order to prepare it for use in the engine.

With certain fuels, especially when much tar is encountered, it is also necessary to add a sawdust purifier in order to abstract the last traces of tar from the gas. While not absolutely essential, it is always advisable to use a gas tank between the scrubber and the engine, in which a certain amount of gas is stored ready for use in the engine. This is especially desirable where the loads are variable. In the care of the producer, the principal attention needed is to poke the fire every few hours, the length of the interval depending on the quality of the coal, in order to break up and remove clinkers, which would otherwise interfere with the making of sufficient gas. Poke holes are provided so that every part of the fire can be reached conveniently.

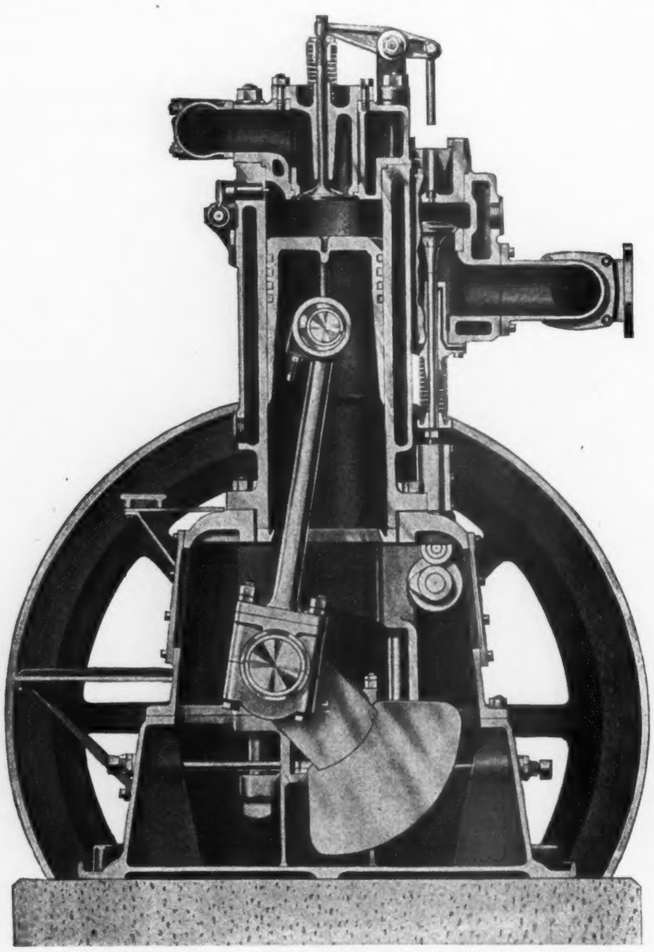


FIG. 5.—SECTIONAL VIEW OF FAIRBANKS-MORSE GAS ENGINE.

### Fuels.

Anthracite in "buckwheat" or "pea" sizes, lignite, coke, and charcoal are the fuels commonly used. In many sections the small sizes of anthracite can be bought cheaply in car lots. For example, in Chicago the car-load price of "buckwheat" anthracite is usually about $3.75 per ton. In some of the States west of Chicago the price varies from $5.00 to $7.00 per ton. At some points in southern Canada these small sizes of Pennsylvania anthracite can be bought for from $3.00 to $4.00 per ton. In some of the Eastern States, which are nearer the source of supply, the prices are even less.

The lignite producer offers a wonderfully cheap and reliable power in sections where this fuel is available. There are enormous deposits of lignite in Texas, Arkansas, Louisiana, North Dakota, Montana, Wyoming, Colorado and other Western States. This can usually be had at a price of from $1.00 to $3.00 per ton. Coke and charcoal are economical fuels in some sections and can be used separately or mixed with anthracite.

In order to give some idea of the relative value of different producer fuels, the results of tests on a number of samples are given. These samples were received from various parts of the United States, as well as from foreign countries. For example, in Table 1, giving the analyses of different anthracites, sample 65 is from Europe, 101 and 76 from Pennsylvania, 71 from Elk Mountain, Colo., and 89 from Banff, B. C., Canada. The tests were made by the experimental department at the works of Fairbanks, Morse & Co., Beloit, Wis.:

TABLE 1—ANTHRACITE.

| Sample No. | B. T. U. per Lb. | Fixed Carbon | Volatile | Ash | Moisture | Sulphur | Quality |
|---|---|---|---|---|---|---|---|
| 65 | 15,434 | 88.8 | 7.4 | 2.9 | .9 | .99 | Very Good |
| 101 | 13,952 | 83.5 | 5.5 | 8.2 | 2.8 | .82 | Good |
| 76 | 12,058 | 73.9 | 5.7 | 18.9 | 1.5 | .86 | Poor |
| 71 | 13,332 | 77.2 | 9.3 | 13.4 | .1 | .73 | Fair |
| 89 | 14,74[illegible] | 79.3 | 8.1 | 10.5 | 2.1 | .59 | Good |

With the best coal there is little formation of clinker that will not work down to the grate without poking from the top, and many European producers have no top poke holes. These are not successful with American coals, for while it is always desirable to get the best coal, it is practical to operate continuously on an average, or even a poor coal, by working the clinkers down through the top poke holes. It is an advantage in using poor anthracite to have large producers.

TABLE 2—COKE.

| Sample No. | B. T. U. per Lb. | Fixed Carbon | Volatile | Ash | Moisture | Sulphur | Quality |
|---|---|---|---|---|---|---|---|
| 73 | 12,787 | 86.7 | 2.4 | 8.4 | 2.5 | .93 | Good |
| 77 | 14,213 | 92.3 | 1.7 | 5.8 | .2 | [illegible] | Very Good |
| 94 | 9,528 | 79.4 | 3.7 | 14.3 | 2.6 | .59 | Rather Poor |
| 97 | 13,811 | 90.4 | 1.7 | 6.1 | 1.8 | .55 | Very Good |

This fuel varies in quality according to the soft coal used in its manufacture and the method of treatment. All coke must be crushed to pass a screen of 1-inch or 1¼-inch mesh, and must be freed from dust with a fine screen. It is usually advisable, where coke is used, to install a one-size larger producer than standard. A sawdust purifier is also desirable to remove the dust, which is more abundant than with anthracite. Gas from coke averages about 115 B.T.U. per cubic foot, while from anthracite it averages 125 or more. For this reason the power capacity of the engine will be a little less on coke gas, but not as much less in proportion as the heating value. Some coke will not maintain the fire hot enough. Mixing one part anthracite with two of coke usually corrects this.

The use of charcoal (14,438 B.T.U. per pound; fixed carbon, 81.3; volatile, 12.9; ash, 1.1), becomes practical by the addition of a centrifugal tar extractor located between the scrubber and a sawdust purifier. With this fuel, also, it is advisable to install a one size larger producer than for anthracite. Charcoal gas has a heating value averaging 130 B.T.U. or more, and because of this gives somewhat more power at the engine. It can be used in as large pieces as will readily go through the producer charging hopper. Less tar results from charcoal that is perfectly charred, but more or less material not perfectly charred is likely to be found. No clinkers are formed with this fuel.

TABLE 3—LIGNITE.

| Sample No. | B. T. U. per Lb. | Fixed Carbon. | Volatile | Ash | Moisture | Sulphur |
|---|---|---|---|---|---|---|
| 51 | 11,634 | 20.3 | 46.1 | 6.3 | 27.3 | 1.01 |
| 57 | 8,753 | 29.4 | 35.7 | 7.1 | 27.8 | .63 |
| 95 | 11,566 | 41.8 | 36.7 | 3.7 | 17.8 | .41 |
| 103 | 9,765 | 36.8 | 35.8 | 10.7 | 17.2 | 4.09 |

Lignite cannot be used in standard anthracite producers, but the Fairbanks-Morse lignite producer operates very successfully with this fuel. Gas from lignite averages 130 B.T.U. per cubic foot. This fuel can be fed to the producer in any size that will go through the charging hopper, and it causes no serious trouble from clinkers.

### PRODUCER GAS ENGINES—VERTICAL TYPE.

These engines are made in sizes of 200 horse power and smaller. By combining several units, plants of 800 to 1,000 horse power or larger have been installed. A section view of the Fairbanks-Morse engine of this type is shown in Fig. 5. It may be of interest to note briefly a few of the carefully developed features in the design of these engines.

The present system of ignition is a great improvement over the methods formerly used. The make-and-break igniter is so constructed that it can be adjusted to spark as early or as late as desired, when the engine is running or at rest, by means of a convenient hand lever. A single lever controls the time of ignition for all cylinders. This is a feature of much importance, especially with producer gas, as it permits timing the ignition to give the greatest possible power and economy with any particular grade of gas, and when the engine is running. In addition, there is an independent adjustment for each igniter which is operated by a drop cam. The igniters can be removed, inspected, and cleaned, without interfering with other working parts. As the successful operation of a gas engine depends largely upon the igniter, the value of these features cannot be emphasized too strongly.

Both valves are mechanically operated from a single cam shaft, which is located inside the crank case. This minimizes the amount of noise, and furthermore the two-to-one reduction of gearing includes a pinion which is made of alternate layers of steel and red fiber. These features insure a quiet running engine.

The simple fly-ball governor is of a carefully designed pattern. It operates a balanced disk valve which is so constructed that there is no frictional contact or surface to become fouled by any impurities in the gas. This is especially important with engines operating on producer gas. The governor insures very close regulation, adapting the engine for electric lighting and other service requiring uniform movement.

Lubrication is effected by means of a single elevated oil reservoir, which is provided with a separate brass pipe with an individual sight feed for each bearing. The drip from the different bearings collects in the base of the engine, which is drained by means of a small pump. The oil is run through a filter and is then used over again.

Each engine is fitted with a hand-operated speed regulator, by means of which the speed can be reduced when the engine is running. One cylinder of each engine is fitted with an automatic compressed air starting gear. This can be thrown into or out of action by the movement of a single lever, and the engine can then be started automatically on compressed air.

### FUEL CONSUMPTION TESTS.

A series of tests have recently been made on a 150 horse power Fairbanks-Morse engine and anthracite producer, for continuous runs of twenty-four hours, at one-quarter load, one-half load, three-quarter load and full load, the object being to determine the comparative economy at different loads. The coal used was an ordinary grade of "buckwheat" Pennsylvania anthracite, running rather high in ash, the analysis being as follows:

| | | | |
|---|---|---|---|
| Fixed Carbon | 78.9% | Moisture | 2.7 % |
| Volatile | 5.3% | Sulphur | 0.77% |
| Ash | 13.0% | B.T.U. per lb. as fired | 13,590 |

Some of the results of these tests, including the coal consumption per brake horse power hour, are given below:

| Load | B. H. P. on Engine | Speed R. P. M. | Coal in 24 Hours | Coal per B. H. P. per Hour | Cooling Water per B. H. P. Hour. Gals. | Steam per Pound of Coal. Lbs. |
|---|---|---|---|---|---|---|
| Full | 149.4 | 224 | 3838 | 1.07 | 5.0 | 0.48 |
| ¾ | 113.1 | 226 | 3185 | 1.13 | 5.6 | 0.45 |
| ½ | 75.4 | 226 | 2369 | 1.3 | 6.8 | 0.41 |
| ¼ | 38. | 228 | 1590 | 1.74 | 13.1 | 0.35 |

Economy tests have often shown a lower consumption than indicated above—frequently less than one pound of coal per brake horse power hour at approximately full load. The figures given are of value as giving the comparative fuel consumption at different loads, and for this purpose they may be considered as conservative and accurate.

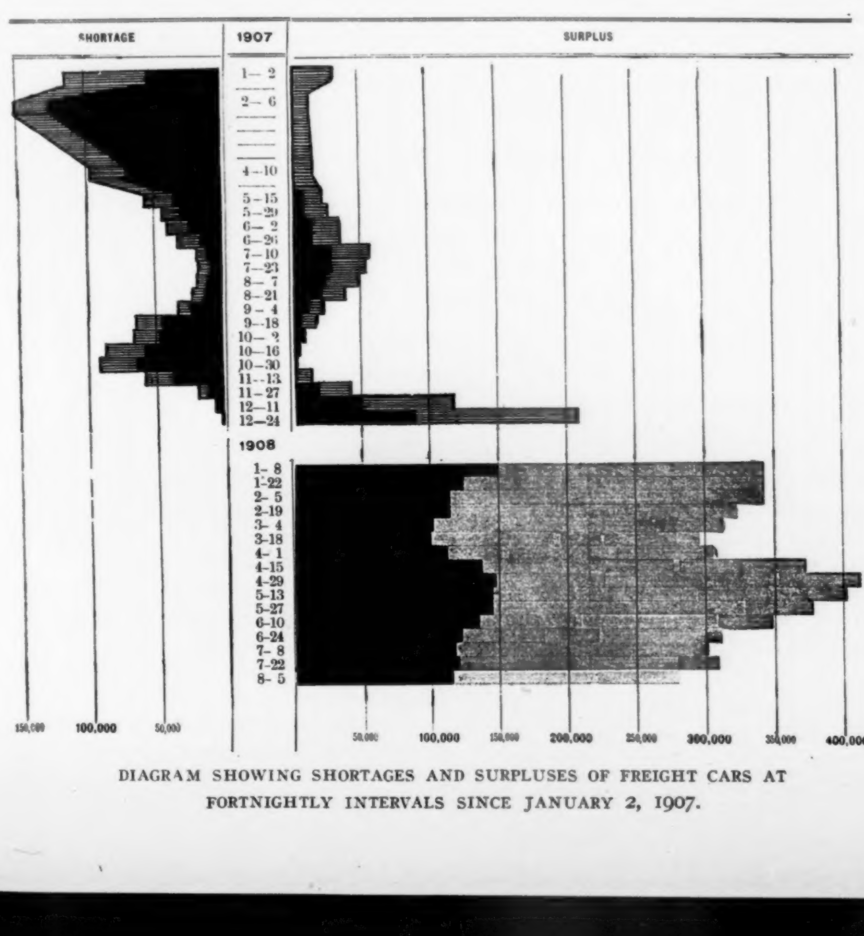



DIAGRAM SHOWING SHORTAGES AND SURPLUSES OF FREIGHT CARS AT FORTNIGHTLY INTERVALS SINCE JANUARY 2, 1907.

## THE FREIGHT CAR SITUATION.

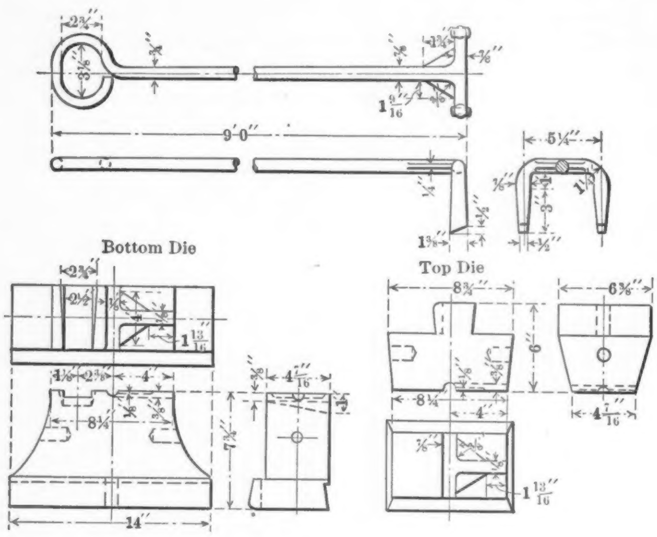
Statistical bulletin No. 29, issued by the committee on car efficiency of The American Railway Association, showed a total of 281,621 surplus cars on August 5, a decrease of 27,059 since the last fortnightly report. Of this decrease 6,505 are box cars, 21,195 coal and gondola, while surplus flat cars increased about 1,000.

Shop reports indicate an increase of about 5,000 in the number of bad order cars, leaving a net improvement of 22,000 cars. The increase in bad order cars is not necessarily an indication of lack of activity in car repairs, but is probably due to the transfer of cars from the available to the shop column on account of defects developing when cars are taken from storage tracks for restoration to service.

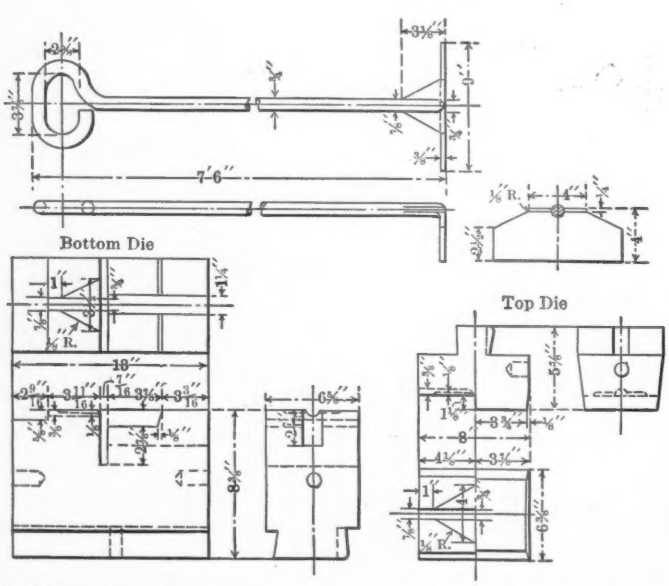
The accompanying chart shows graphically the surpluses and shortages as taken from the fortnightly reports since January 2, 1907. The black parts represent box cars and the shaded portions other types of freight cars.

## IMPROVED DESIGNS OF FIRE HOOK AND ASH SCRAPER.

The ordinary types of fire hooks and ash scrapers are weak at the junction of the scraper, or hook, and the handle and are frequently consigned to the scrap pile after two or three trips over the road. The drawings show improved designs of a fire hook and an ash scraper, together with the hammer dies for making them, as designed by A. W. McCaslin, foreman blacksmith of the Pittsburgh & Lake Erie Railroad at the McKees Rocks shops. These tools are made with a web at the junction of the handle and the hook, or scraper, making them practically unbreakable at that point under ordinary usage. In making the scrapers, that portion constituting the scraper blade and the web




IMPROVED FIRE HOOK AND HAMMER DIES FOR ITS MANUFACTURE.




IMPROVED ASH SCRAPER AND HAMMER DIES FOR ITS MANUFACTURE.

is punched to shape, from a ⅜ in. iron or steel plate, at one blow of the steam hammer. The web is then bent over at right angles and is ready to be welded to the handle. These two operations cost about one cent.

The eye is bent on the handle rod and the other end of the rod is upset to 1 in. in diameter, 3 in. long, on a small pneumatic bulldozer, these two operations costing less than one cent. The blade is then welded to the handle by means of the steam hammer dies shown. When at a welding heat the blade is dropped in the groove that is cut crosswise of the bottom die, the handle is placed on the top side of the web and two or three blows of the hammer make the weld and form the web. The first hooks were made so that the handle bent down over the back of the scraper, making a heavy half round brace at the bend, but this extra strength was not required and the practice was discontinued. The fire hook is made in a somewhat similar manner, the dies being shown in detail on the drawing.

## OXY-ACETYLENE PROCESS FOR WELDING AND CUTTING.

A paper entitled "History and Status of the Oxy-Acetylene Process in America" was presented by Augustine Davis at the recent meeting of the International Acetylene Association in Chicago. Parts of this paper, referring to the field of usefulness of the oxy-acetylene process, its present status, and giving approximate figures as to the cost of welding and cutting steel by this process, are reproduced as follows:

Autogenous welding is the uniting of metals by heat, without either flux or compression. While this object has been obtained, to some extent, by the use of oxy-gas and oxy-hydrogen, it is only very recently that a really satisfactory method has been developed through the oxy-acetylene process. It is obvious that very high temperature, full control and facility of application are necessary requisites for great efficiency.

The highest temperature of the best solid fuel furnaces is about 3,000 F. The oxy-hydrogen, which was the hottest of the gas flames, is something less than 4,000 F. The oxy-acetylene flame jumps this temperature more than 2,000 F. to about 6,300 F., being more than double the hottest solid fuel heat known. As acetylene produces about five times more heat per cubic foot than hydrogen, and nearly doubles it in intensity, a marvelously powerful flame is condensed into very small volume. Compared to the oxy-hydrogen flame, it is like a finely-pointed tool to a blunt instrument. With such a tool, having heating power from two to three times that required to melt the commercial metals, almost incredible results are obtained.

By this process iron, steel, cast iron, aluminum, brass, copper and other metals can be so perfectly united that when smooth the joint cannot be discerned. Containers for fluids and liquids can be made without joints, and will not leak when bruised or dented, as will riveted vessels. Blow-holes and other defects in iron, steel, brass and other castings can be repaired, not only saving the castings, but many times expensive machine work as well. Quickly repairing broken machines, boilers and steam and other piping in place is one of the most valuable features of this process, not only saving the articles themselves, but what is often of vastly more importance, preventing long and expensive suspension of operations, while repairs are being made. Worn parts of machinery and teeth on gear wheels can be built up; tool steel added to common steel; dies repaired, and numberless other operations accomplished which are not possible by other methods. The repair of aluminum automobile casings, and cast iron cylinders is a large business in itself. Not only can metal of the same kind be united, but those of different kinds can be perfectly united.

The facility with which steel and iron (except cast iron) can be cut is really marvelous. The operation is performed by heating the metal at the first point of contact to the red by the ordinary welding flame, and with this flame continued, a jet of pure oxygen is turned on which unites with the carbon of the metal and disintegrates it with surprising rapidity. The cut is narrow and smooth, with no material injury by oxidation. The cut can be made in any shape, and the process will be found very useful in cutting irregular forms, and will be valuable, especially in making many kinds of dies and in fitting steel plates. It is very effective for cutting steel beams in structural work.

The A. Boas, Rodrigues & Co. torch, known here as the Davis-Bournonville, has been improved in design and construction until it is now practically perfect. All of the authorities have given 2.5 parts of oxygen to 1 of acetylene, as the theoretical quantities required, and 1.8 of oxygen to 1 of acetylene, as the quantities actually used in practice. With their apparatus and torch the Davis-Bournonville Co. has succeeded in securing a perfect welding flame, with only 1.28 parts of oxygen to 1 of acetylene,

**APROXIMATE COST OF OXY-ACETYLENE WELDING.**

**Oxygen at three cents—Acetylene at one cent per cubic foot. Labor 30 cents per hour.**

| Tip Number | Thickness of Metal | Consumption of Acetylene Per Hour | Consumption of Oxygen Per Hour | Proper Pressure in Pounds for Oxygen | Lineal Feet Welded Per Hour | Cost of Labor Per Hour | Total Cost Per Hour | Cost Per Lineal Foot |
|---|---|---|---|---|---|---|---|---|
| 1 | $\frac{1}{32}$ to $\frac{1}{16}$ | 2.8 feet | 3.6 feet | 8 to 10 lbs. | 50 feet | .30 cents | .436 | .0087 |
| 2 | $\frac{1}{16}$ to $\frac{3}{32}$ | 4.5 " | 5.7 | 10 to 12 " | 30 " | 30 " | .516 | .0172 |
| 3 | $\frac{3}{32}$ to $\frac{1}{8}$ | 7.5 " | 9.7 " | 12 to 14 " | 25 " | .30 " | .666 | .0266 |
| 4 | $\frac{1}{8}$ to $\frac{1}{4}$ | 11.7 " | 15. " | 14 to 18 " | 16 " | .30 " | .867 | .054 |
| 5 | $\frac{1}{4}$ to $\frac{5}{16}$ | 18. " | 23. " | 18 to 22 " | 10 " | .30 " | 1.17 | .117 |
| 6 | $\frac{5}{16}$ to $\frac{7}{16}$ | 25. " | 32. " | 20 to 25 " | 7 " | .30 " | 1.51 | .216 |
| 7 | $\frac{7}{16}$ to $\frac{1}{2}$ | 32.5 " | 41.5 " | 22 to 27 " | 5 " | .30 " | 1.87 | .374 |
| 8 | $\frac{1}{2}$ upward | 48.5 " | 62. " | 24 to 30 " | | | 2.64 | |

**APPROXIMATE COST OF CUTTING STEEL.**

| Number Cutting Tip | Use Welding Tip No. | Thickness of Steel | Heating Jet. Feet of Acetylene | Heating Jet. Feet of Oxygen | Cutting Jet. Feet of Oxygen | Pressure of Oxygen Heating Jet | Pressure of Oxygen Cutting Jet | Lineal Feet Cut Per Hour | Labor Per Hour | Total Cost Per Hour | Cost Per Lineal Foot |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 4 | up to $\frac{1}{2}$" | 12 | $15\frac{1}{2}$ | 60 | 14 to 18 lbs. | 125 lbs. | 60 | .30 | 2.68 | .0447 |
| 2 | 4 | $\frac{1}{2}$" to $1\frac{1}{2}$" | 12 | $15\frac{1}{2}$ | 75 | 14 to 18 " | 125 to 150 | 50 | .30 | 3.13 | .0627 |
| 3 | 5 | $1\frac{1}{2}$" up | 18 | 23 | 75 | 18 to 22 " | 150 to 175 | 40 | .30 | 4.02 | .1005 |

not only effecting a very material saving in the cost of operation, but obtaining better results as well. An imperfect mixture of gases is not only much more expensive, but an excess of oxygen oxidizes the metal, and too much acetylene carburets it, either condition being seriously detrimental.

Railway companies are particularly interested. At one of the large railway shops, several repairs to locomotive boilers have been made, obviating the expensive removal of defective sheets. An extensive demonstration is being made at this shop, the results of which are being awaited by several other railway companies with much interest. Recently about twenty split boiler tubes were welded by this process, all of which were then burst by excessive pressure, but not one of them parted at the weld. Some months since, J. G. Stevenson, of the Baltimore & Ohio Railway Co., made some tests and obtained 94 per cent. of the original strength of cast steel and 88 per cent. of rolled steel. The experience in operation since has undoubtedly improved this kind of work.

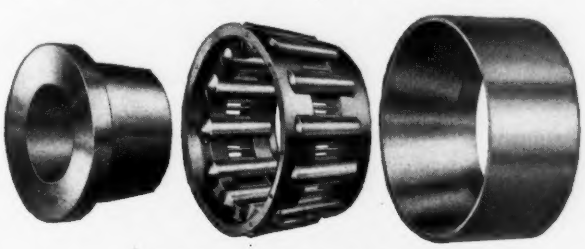
In the railway shops, where these tests are being made, thermit is successfully used in welding heavy locomotive frames, but it is believed that the oxy-acetylene process can be used to great advantage in preparing the frames for the operation, and in cutting away the excess of very hard material afterwards. Recently about 70 feet of steel piling, running from ⅜ in. to 2¼ ins. in thickness, and a number of steel beams were cut in the construction of a building in New York. A 15-in. I-beam was cut in four minutes. Cast iron welded by this process rarely breaks in the weld. Cast iron welded to steel breaks in the original cast iron instead of where joined to the steel.

The development of this process is scarcely begun, and its field is almost without limit, but as previously stated, it is an art which will require intelligence, fertility, patience and experience to secure the marvelous results of which it is capable. Pure oxygen and acetylene and the best apparatus possible to produce them are absolute requisites. Short cuts, cheap apparatus and incapable operators are certain to retard progress greatly. Where the process is to be used over and over on the same kind of work, a conscientious operator of very ordinary ability, can, within a few weeks, become quite expert, but where a very large variety of work is to be performed, knowledge of metals, resourcefulness, personal interest and experience are indispensable.

A carefully prepared table, showing the approximate cost of cutting and welding is appended hereto, and will be found of much interest to investigators.

## IMPROVED ROLLER BEARING.

A new Grant roller bearing has recently been produced by the Standard Roller Bearing Company of Philadelphia. The new bearing has conical or tapered rollers, but they are solid. The



IMPROVED GRANT ROLLER BEARING.

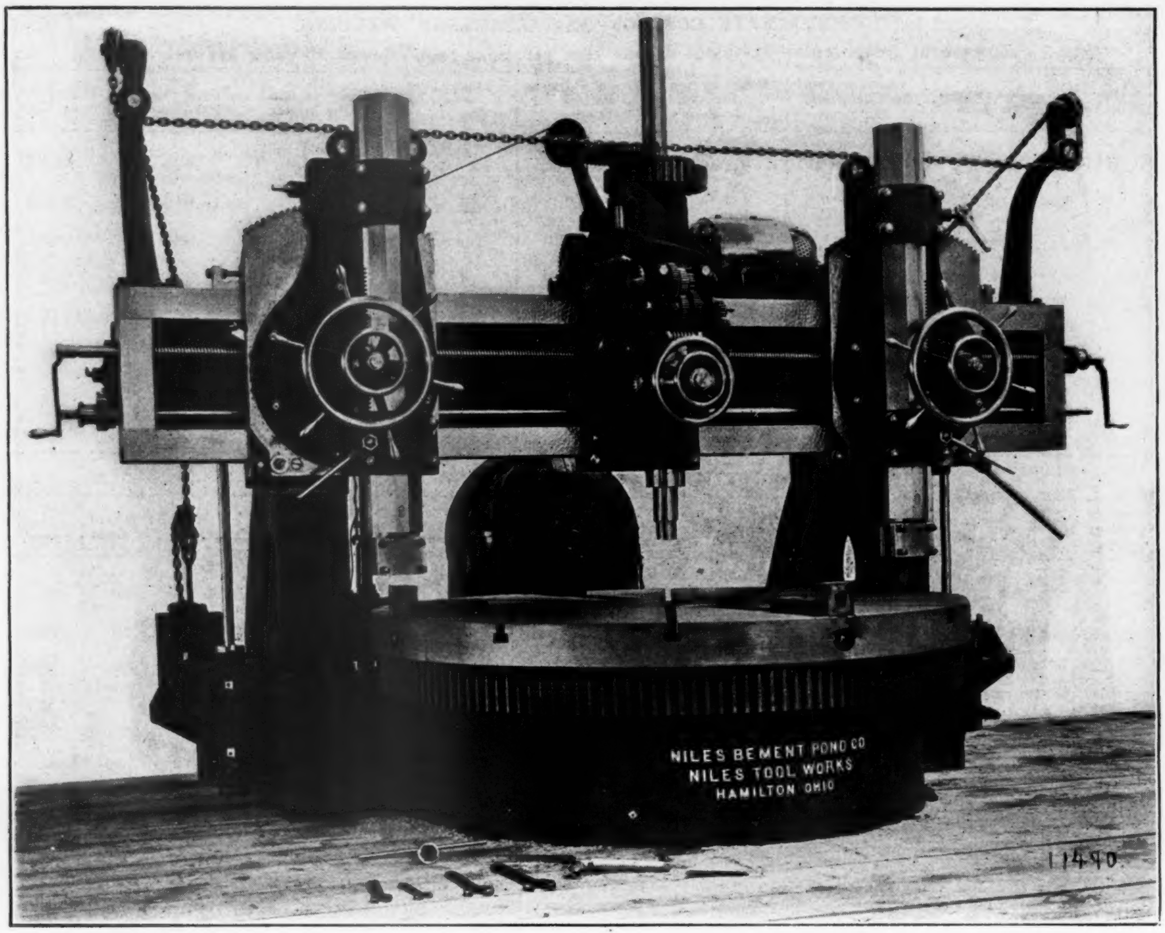
races and cones are made of special steel, with the temper drawn, so that they are very tough and will not chip or break under the most severe service.

The cage or retainer holding the rolls is made of the same general type as that used so successfully by the company for many years on its standard journal roller bearing; it consists of individual sockets or races, in which the ends of the rolls rest, and is made of solid steel with the two ends securely riveted together by a special electric riveter, giving the strongest form of cage or retainer that can be devised; the hot riveting makes the cage substantially solid or one-piece; it is impossible for it to twist or get out of shape, and, as there are no small journals or pins on the rollers, it makes an exceedingly strong bearing.

The cone has an especially wide shoulder, against which the ends of the rollers have a bearing, practically to the center of the roll, the shoulder having the same degree of bevel as the ends of the rolls. The entire thrust is taken in this manner, giving great durability and strength to the bearing.

The bearing is made interchangeable with other forms of conical or tapered roller bearings and its construction is such that it will carry a heavier overload than usual.

AMERICAN STREET AND INTERURBAN RAILWAY ASSOCIATION.—The annual meeting of this association will be held at Atlantic City, October 12-16. The secretary is B. V. Swenson, 29 West Thirty-ninth Street, New York City.




TIRE BORING MILL SIMILAR TO ONE USED AT C. & N. RY. SHOPS, EXCEPT THAT IT HAS A CENTER BORING HEAD.

## RAPID TIRE BORING.

CHICAGO & NORTHWESTERN RAILWAY.

The Chicago & Northwestern Railway some time ago installed in its Chicago shops a boring mill which is specially adapted for boring driving wheel tires and is not used for any other purpose. Fifty-four 56-in. tires have been bored on this machine in eight hours and fifty-seven minutes. The roughing and finishing cuts were taken at the same time, the cutting speed being at the rate of 30 ft. per minute. The feed was at the rate of ½ in. per turn of the table and the amount of stock removed varied from 1/16 to 3/16 in. on the radius. Two swinging jib cranes, with air hoists, serve the machine and the machinist was assisted by two helpers when the above record was made. When the machine was first installed it was served by one crane only and the best record which it was possible to make under these conditions was forty-one 56-in. tires in nine hours, or thirteen less than was possible after the second crane was installed.

The machine was furnished by the Niles-Bement-Pond Company, and is similar to the one shown in the photograph, except that it is not equipped with the center boring head. It has a stationary cross rail and two heads, and is equipped with a four jaw universal chuck which is used for centering the tires only, special holding clamps being used which are inserted in the T slots between the universal jaw slots. These were designed by Oscar Otto, the general foreman. The table is supported by a wide track just inside the main driving gear. A large spindle attached to the center of the table extends down a considerable distance below the base of the mill, furnishing a rigid support to the table for withstanding the heavy cuts. Sixteen feeds of the positive gear type are provided.

The mill is driven by a General Electric 25 h.p. motor with a 2 to 1 speed variation, operated on a 220 volt direct current circuit. The motor is geared direct to the speed box, which mechanically furnishes four changes of speed. From the speed box power is transmitted through a pair of bevel gears to a vertical shaft carrying a pinion which engages with an external gear, nearly the full size of the table.

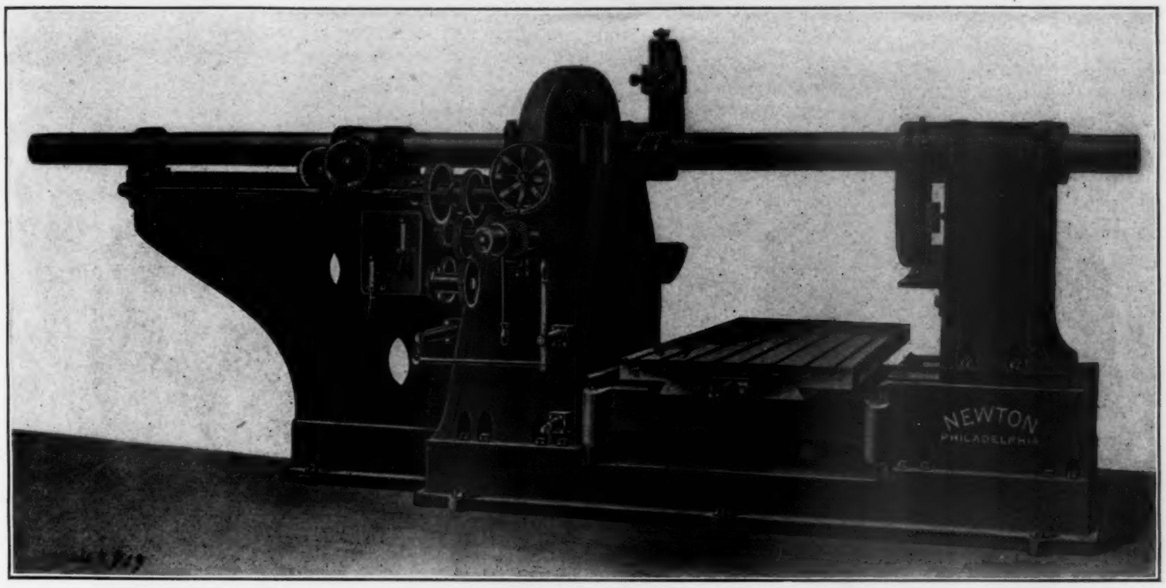
## VARIATIONS IN AVERAGE PRICES.

The variations during the eighteen years since 1890 are summarized in a table just issued by the Bureau of Commerce and Labor. The average price from 1890 to 1899 is taken as 100. The average is made up from the wholesale prices of 258 staple

| Year. | Relative price of all commodities. | Year. | Relative price of all commodities. |
|---|---|---|---|
| 1890 | 112.9 | 1899 | 101.7 |
| 1891 | 111.7 | 1900 | 110.5 |
| 1892 | 106.1 | 1901 | 108.5 |
| 1893 | 105.6 | 1902 | 112.9 |
| 1894 | 96.1 | 1903 | 113.6 |
| 1895 | 93.6 | 1904 | 113.0 |
| 1896 | 90.4 | 1905 | 115.9 |
| 1897 | 89.7 | 1906 | 122.5 |
| 1898 | 93.4 | 1907 | 129.5 |

articles and the figures may be taken as representing the variation in the cost of living or the changing value of the gold dollar, since the value of a dollar is really measured by the amount of goods it will purchase.—*Engineering News.*

THE TOTAL PANAMA CANAL EXCAVATION since the American Government took possession in May, 1904, to the end of the fiscal year, June 30, 1908, totals 40,938,575 cu. yd., this figure including the earth moved from the canal prism and from the accessory works. Of this amount 27,979,375 cu. yd., or about 66 per cent. of the total, has been taken out in the last fiscal year, as against 8,623,052 cu. yd. during the preceding year, and 3,423,021 cu. yd. during the year ending with June, 1906. The records of last year show that the steam shovels removed 17,457,161 cu. yd., the dredges 10,399,417 cu. yd. and that 122,797 cu. yd. were handled by other methods. In the Culebra cut the steam shovels excavated 12,005,360 cu. yd., and 59,778 cu. yd. were taken out by other means.




NEWTON SPECIAL CYLINDER AND VALVE CHAMBER BORING MACHINE.

## CYLINDER AND VALVE CHAMBER BORING MACHINE.

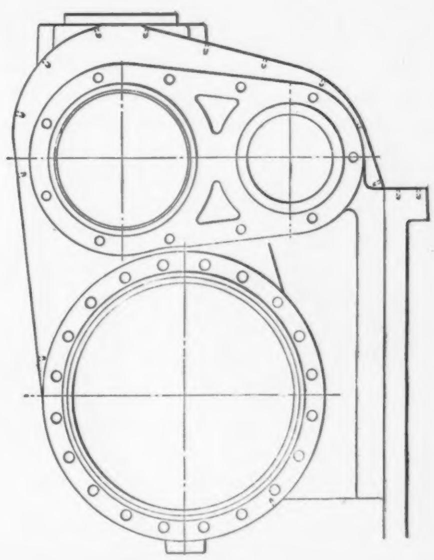
The accompanying illustration shows a special cylinder boring machine, designed by the Newton Machine Tool Works, Inc., Philadelphia, for boring any class of simple or compound engine cylinders and piston valve chambers at one setting. It is said that a simple cylinder and valve chamber can be bored in five hours. Where inclined cylinders are used an auxiliary table may be furnished which can be swiveled to bore at an angle of 20 degrees.

After a cylinder has been planed it is placed on parallel strips on the table of the boring machine, and by means of the vertical, transverse and longitudinal adjustments the high and low pressure cylinders and valve chamber of a compound locomotive may be bored at one setting. This insures the alignment of the cylinders, and by the use of gauges the proper distance between centers may be maintained. A typical example of the work which may be accomplished in this way is illustrated by the sketch.

The spindle has a speed range of from 4 to 15 r.p.m. and may be driven by either a four step cone pulley belt drive or a 20 h.p., 3 to 1 variable speed motor. The drive is connected to the spindle through a clutch, so that the spindle may be started or stopped without stopping the motor or countershaft. The motor is fitted with a fly wheel to overcome the shock of engaging the clutch. The spindle is 7 in. in diameter and is fitted with two splines for driving. It is ground and fitted in sleeves, one in each bearing. The sleeve in the main pedestal drives the spindle through a phosphor bronze worm wheel, 41 in. in diameter, and a hardened steel worm with a roller thrust bearing; the worm and worm wheel are encased and run in oil. The other sleeve is in the foot-stock or outboard bearing and is keyed to the spindle and revolves with it. Both of these sleeves are lapped in the hole for the spindle so as to insure a proper bearing, and are ground on the outside and fitted in brass bushings which are accurately scraped, a cap bearing being provided for compensating for wear.

To each of these sleeves is fitted a special design of facing arm, which can be engaged or disengaged without stopping the spindle motion; on each facing arm is fitted a tool slide, with in and out adjustment for setting the depth of cut; the tool slide has a feed in either direction on the arm, by means of star wheel and pins. The spindle is fed forward by a trolley or carriage, operated by a screw and nut, and has a continuous motion of 140 in. so that it can be entirely withdrawn for removing cylinders at a single transverse motion. The outboard, or foot-stock, bearing is adjustable by means of a rack and pinion to give a minimum distance between the facing arms of 45 in. and a maximum distance of 60 in.

The cross adjusting table is fitted with steel plates on the top, which gives a steel web to the T-slots and prevents the edges from breaking out; it also maintains the alignment of the top of the table. The table has both hand and power adjustment and is adjustable longitudinally on the knee in order to bring different lengths of cylinders central between the facing arms. The knee is accurately fitted between the bed, and is supported by four screws, 6 in. in diameter, which are used to raise and lower the table, and properly support it to give a minimum distance from center of spindle to top of table of 43 in. and a

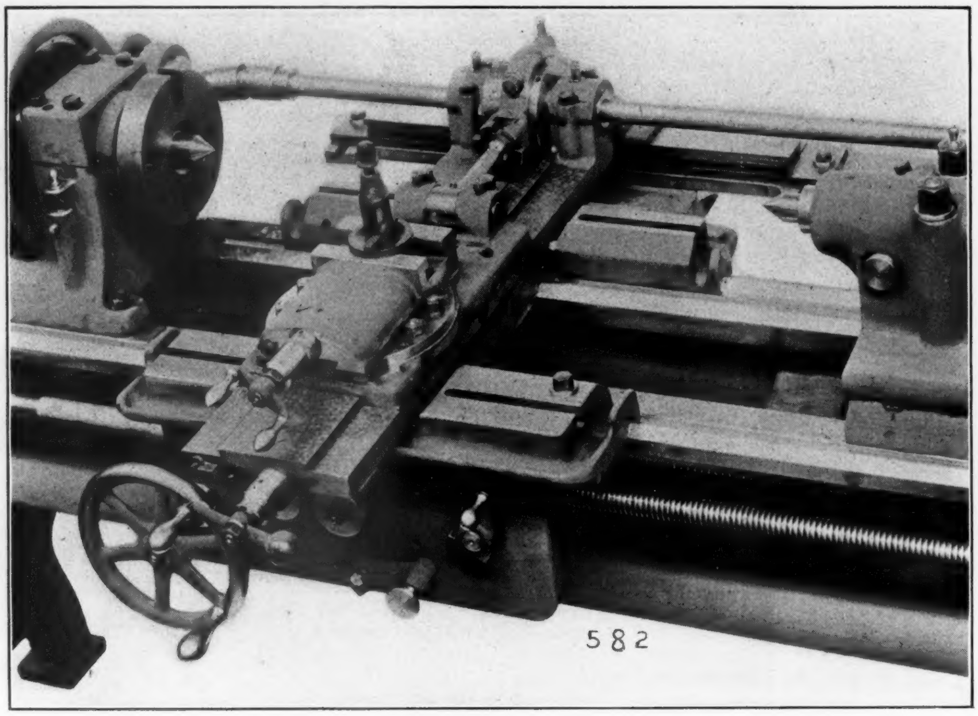


ILLUSTRATING WORK WHICH MAY BE BORED AT ONE SETTING.

maximum distance of 51 in. The table is raised and lowered by power with a fine hand adjustment.

Six changes of feed in either direction are supplied to the spindle through the gear box, the feeds amounting to 0.062, 0.100, 0.166, 0.333, 0.667 and 1 inch per revolution of spindle. The feed is engaged by the lever above the feed box, which when moved to the left engages the feed, and when moved to the right engages the quick traverse, both of these movements being reversed by the lever directly under the hand-wheel in front of the machine. The quick power motion in either direction is at the rate of 10 feet per minute.

NATIONAL MACHINE TOOL BUILDERS' ASSOCIATION.—The regular annual meeting of this association will take place, October 20 and 21, in New York City. The headquarters will be at the Hotel Imperial, Broadway and Thirty-second street.



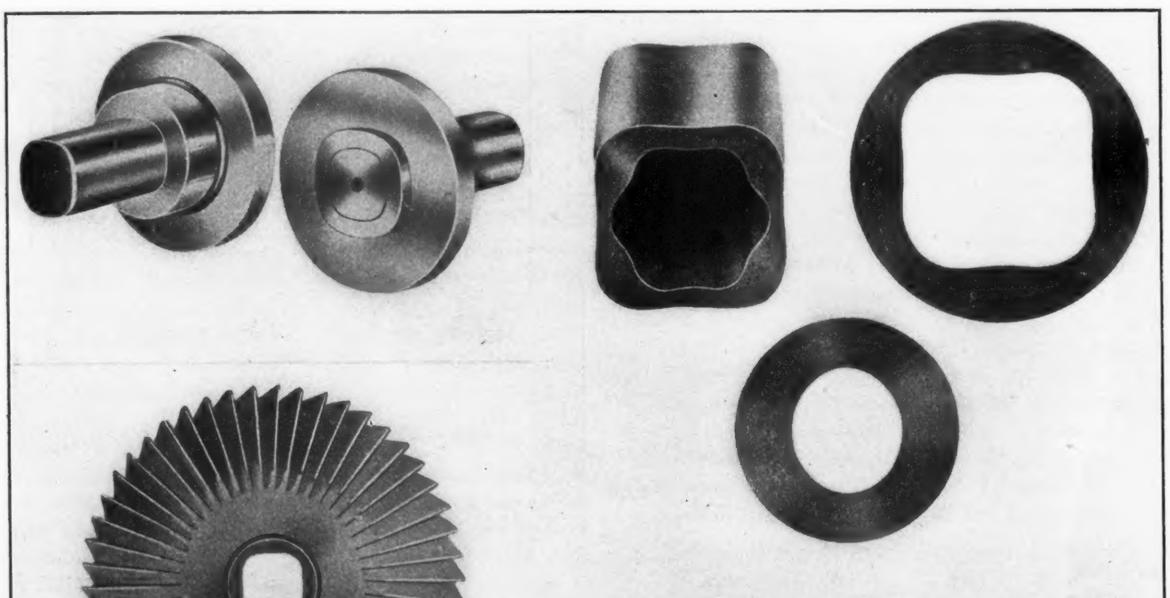

THE DERRER UNIVERSAL SHAPE ATTACHMENT APPLIED TO A LODGE & SHIPLEY LATHE.

## THE OVAL DRIVE AND ITS USES.

The Derrer universal shape attachment, or oval drive, exhibited at the Atlantic City conventions by the Lancaster Machine & Knife Works, Lancaster, N. Y., will undoubtedly find a considerable field of usefulness and prove of great value in railroad shop tool rooms. The exhibit consisted of a Lodge & Shipley Machine Tool Company three step cone, double back geared, standard screw cutting engine lathe, on which was mounted a Derrer universal shape attachment. This is a simply constructed device, having sensitive and quick adjustment for turning and boring a wide range of hitherto unobtainable shapes, such as eccentrics, ovals, cams and squares, which may be made either straight or taper at a low labor cost.

The lengthened lathe spindle carries a gear that drives through an intermediate into a gear upon the splined shaft, shown at the rear of the lathe. Suitable gears are furnished to give this shaft ratios to the spindle of 1 to 1 for eccentrics, 2 to 1 for ovals, 3 to 1 for cams, 4 to 1 for squares, and increased ratios for greater polygons. The length of the shaft is such that the attachment will operate at any point between the centers of the lathe or on chuck work, a pair of universal joints insuring the alignment of the shaft to the bearings.

The eccentric discs are mounted upon a long lower slide that



UPPER LEFT HAND CORNER—SHAFT COUPLING, SPECIAL SHAPE; UPPER RIGHT HAND CORNER—SAMPLES OF WORK MADE WITH THE OVAL DRIVE; LOWER LEFT HAND—MILLING CUTTER ARRANGED FOR SPECIAL SHAPE ARBOR; LOWER RIGHT HAND—SHELL REAMER WITH OVAL TAPER ARBOR.

moves directly upon the bridge of the lathe carriage and extends out and over the taper attachment and is bolted to the shoe or sliding block on the taper dovetail; consequently taper ovals, eccentrics, squares, etc., may be bored and turned. The bearing blocks are cast integral with the slide. In these bearings is a sleeve carried upon the splined shaft and free to revolve with it. Two eccentrics, one within the other, and the bronze eccentric strap coupled directly to the compound rest slide, complete the drive. By easily made adjustment it is possible to obtain any throw from zero to the combined throw of both eccentrics. On the 16 in. lathe this maximum is ½ in. for ovals, squares and cams, but this can be increased to almost any throw by special eccentrics and by lengthening out the crotch of the cross slide. A graduated disc makes it a simple matter to obtain the desired throw quickly. Solid eccentrics (not adjustable) may be substituted for the above, when a large quantity of duplicate work is required.

As the tool is at all times tangent to the cut in boring and turning (either straight or taper), two ends of a taper hole


LANCASTER OVAL TAPER DRILL SOCKET.

would have similar ellipses, the large and small axis having a constant ratio to each other. In boring or turning shapes the lathe is run with the same precision as in turning or boring rounds. For taper round turning, disengage the gear driving the shaft on the end of the spindle. For straight round turning, disengage the gear and back off the dog of the taper attachment. Either of the above changes may be made in less than a minute's time. Ample oiling facilities are provided for all wearing surfaces of the attachment. In addition to the above described equipment, a depth gauge is fitted to the compound rest screw whereby all diameters can be easily and positively duplicated in boring or turning. A gauge is also furnished for locating the cutting edge of the tool for all cutting conditions.

APPLICATIONS.

An important application of this drive is its use in connection with milling cutters, shell reamers and all similar tools, at present held in place by methods that cause much loss through cracking in hardening in their manufacture. Tool steel has a tendency to crack at sharp corners and the elimination of keyways by using a specially shaped arbor would greatly reduce this trouble and at the same time furnish a stronger and more satisfactory method of holding the tool.

The use of the flat tang for holding twist drills has not proved satisfactory, and the manufacturers and users of such tools have been striving for years to perfect some scheme for holding drills for true driving at all times, and without injury to the shank of the drill. The Lancaster oval taper drill socket, shown in the illustration, is made possible by the oval drive. The company is placing a full line of these drill sockets and sleeves on the market, and is prepared to furnish twist drills of standard make with shanks turned to accurately fit the sockets. These sockets have given very satisfactory results. A standard taper of ⅝ in. to the foot has been adopted.

The use of the oval drive in the manufacture of shaft couplings insures a permanent, lasting union, that is practically indestructible. By using the square design with ends of the shafts tapered, a most secure and positive drive is procured without the use of keys, screws or other holding devices. The couplings can be separated quickly and be again put together without the necessity of refacing, as is customary in the present readjustment of flange couplings.

The drive may be used to advantage in many instances for the fastening of gears to shafts, instead of keying them; for turning the shafts for back gears and for many other similar purposes. The oval drive has been in practical and constant use at the plant of the Algoma Steel Company, Ltd., Sault Ste Marie, Ontario, for two years.

## LOCOMOTIVE FEED WATER HEATER TESTS.

A feed water heater for locomotives which was designed by F. H. Trevithick, superintendent of motive power of the Egyptian State Railways, and applied by him to several locomotives on that system, was illustrated and described on page 436 of the November, 1907, issue of this journal. A series of tests which were recently made with this heater are reported in a pamphlet being issued by the North British Locomotive Company, Ltd., at the Franco-British Exhibition, from which the following results are taken.

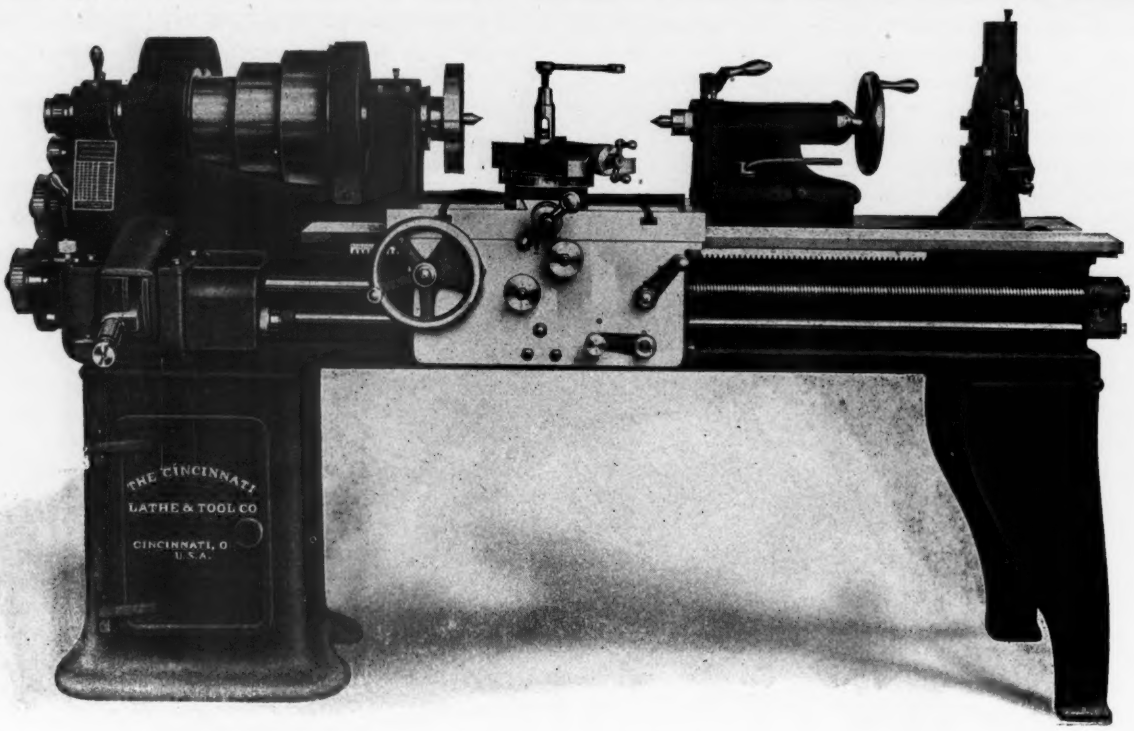
The first series of trials consisted of comparing the results in regular operation of a locomotive, both with and without the heaters. These tests covered 14 trips from Cairo to Alexandria, a total of 1,820 miles with heaters, and 18 trips, 2,340 miles without them. The average consumption of coal per mile with a train which averaged 219 tons was 27.32 lbs. without heaters and 22.12 lbs. with them, a difference of 19 per cent. The evaporation per lb. of coal was 9.77 lbs. of water without heaters and 12.31 lbs. with them, a difference of 26 per cent. A series of runs were then made for obtaining the average temperature of the feed water after passing through the heaters. This was found to average 260 degrees, including temperatures obtained while standing, and 252 degrees while running only.

A test of the evaporation efficiency of a locomotive fitted with heaters as against a similar engine without them gave a result of 26 per cent. in favor of the former.

The next series of tests were a comparison in regular service of a locomotive fitted with heaters with a duplicate engine not so fitted and operating in the same service. These tests covered a distance of 7,280 miles in passenger service in each case and showed an average fuel economy in favor of the heaters of 22.4 per cent. per train mile and 23 per cent. per ton mile.

All of these tests were carried out with the greatest care and fairness. The full account of the methods used and the detailed results are given in the pamphlet mentioned.

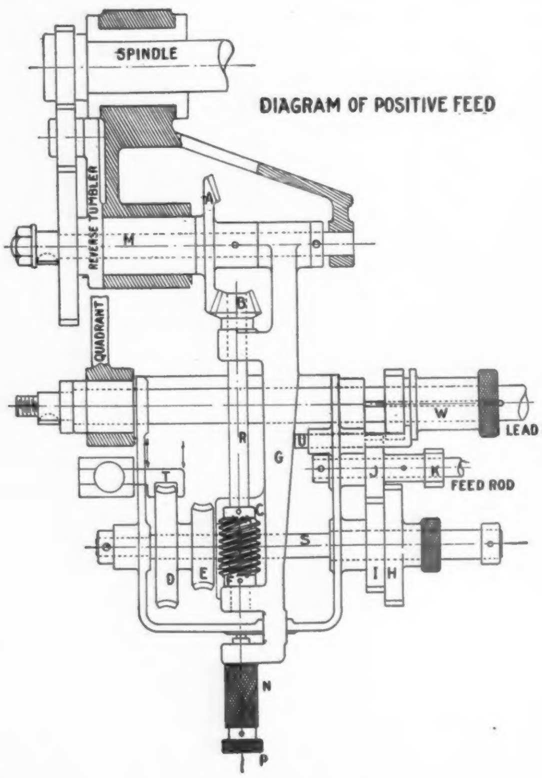
TIMBER PRODUCTION.—Optimistic people when urged to lend their influence for forest preservation and restoration sometimes say that cement and concrete are going to take the place of lumber and so reduce the drain on the forests. Perhaps the prediction may be realized, but the figures for lumber production in 1907 give no hint of such relief. Lumber production is growing instead of falling off. The total of 1907 was 3,000,000 M. ft. greater than in 1906, and exceeded 40 billion ft. B. M.—*Engineering News.*




SIXTEEN-INCH LATHE WITH NEW GEARED FEED DEVICE.

## CINCINNATI SIXTEEN INCH LATHE WITH NEW GEARED FEED DEVICE.

Those who are familiar with the instantaneous change gear engine lathe with the W. T. Emmes patent feed device, made by The Cincinnati Lathe & Tool Company, Cincinnati, Ohio, will be interested in a recently designed lathe with a new type of positive geared feed which that company has placed on the




market. The former design was of special value for screw cutting, as it was possible to obtain any one of forty positive changes for that purpose by simply manipulating two knobs.

The details of the new geared feed device are shown on the drawing. The shaft M is connected to the spindle by a train of gears. The bevel gear A, which is keyed to M, drives pinion B on shaft R, to which the worm C is keyed. Shaft R is supported by the bracket, or arm G, which swings on the shaft M. G can therefore be moved up and down by means of the handle N, thus making it possible to have worm C mesh with either one of the three gears D, E or F. The worm gears are shifted by the fork T. Through the two pairs of gears I and J, and H and K, the three speeds at which it is possible to drive shaft S are doubled when transmitted to the feed rod, thus making six feeds available, which is all that are usually necessary on a 16-inch lathe for general manufacturing purposes. Twenty-two additional feed changes, ranging from 5 to 64 per inch, may be secured through the lead screw by sliding gear W into mesh with gear J on the feed rod. Safety stop U prevents the two feeds from becoming engaged at the same time. The 4 pitch lead screw cuts threads from 2 to 24 per inch, including 11½, and an unlimited number of other feeds may be obtained by ordering extra change gears for screw cutting. Arrangements are provided to oil the gears well.

The sixteen inch lathe illustrated has a swing over the bed of 16½ in., a swing over the carriage of 10¼ in., and may be equipped with either a three or a five step cone driving pulley. The back gear ratio with the five step cone is 10 to 1. Double back gears are provided with the three step cone, the back gear ratios being 3⅓ and 9½ to 1. The carriage has a bearing 22 in. long on the bed and the lathe with a 6 ft. bed weighs about 2,000 lbs.

A taper attachment may be added to the lathe at any time and permits turning tapers from 0 to 4 in. to the foot and 12 in. long at one setting. Where desired the lathe may also be furnished with a draw-in attachment, oil pan and a turret on the carriage.

**Underground Railroads in Paris.**—Paris has 32 miles of underground railroad in operation, and 25 additional miles are in process of construction. About 350,000 passengers are being carried per day. The system has a double track tunnel throughout, except where it crosses under the Seine, through two iron lined tubes, each 16.4 ft. inside diameter.

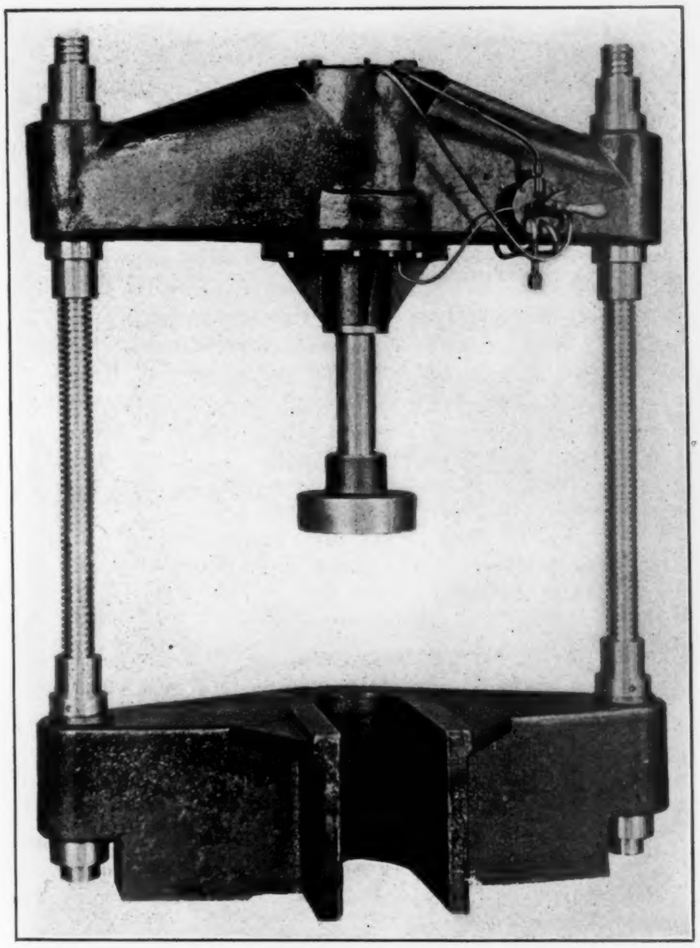
**Master Car and Locomotive Painters' Association.**—This association will hold its annual meeting at Atlantic City, September 8 to 11. A. P. Dane, B. & M. R. R., Reading, Mass., is the secretary.

## PNEUMATIC PRESS.

A recently designed pneumatic press, suitable for railroad shop work, is shown in the illustration. The Springfield Machine Tool Company, Springfield, Ohio, designed and built one of these presses for their own use; it proved so successful that the company has decided to manufacture and place them on the market. When supplied with an air pressure of 80 lbs. per sq. in. the press is capable of exerting a pressure of 8,800 lbs. An auxiliary air pump, not shown in the illustration, may be thrown into action, which increases the capacity of the press to 27,000 lbs. The base of the machine is of heavy construction and large enough to take a piece of work 40 in. wide.

The opening in the base casting extends back beyond the center of the machine and permits a portion of the work, such as a shaft or pin, to extend a considerable distance below the top of the base.

The upper frame casting contains in its center the air cylinder, 12 inches in diameter, the piston having an 8-inch stroke;



SPRINGFIELD PNEUMATIC PRESS.

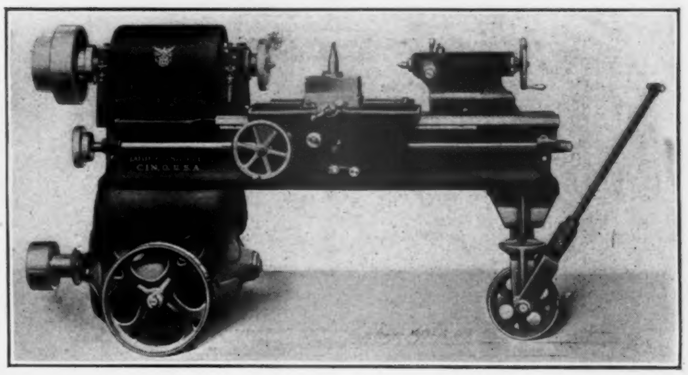
if required the stroke can be made longer. The piston is fitted with three rings, which prevents air leakage. The lower end of the piston rod carries a heavy circular shoe, the central portion of which is filled with babbitt, so that the work will not be bruised when the pressure is applied. The two uprights are threaded to permit adjusting the upper casting to the height required by the work. By the use of the adjusting screws the press can be made to accommodate a great variety of work.

The control of the air for the cylinder is through a valve at the right-hand side of the upper frame casting. The valve is very simple in its operation. As it is moved from the left-hand position the piston is raised, while a further movement will shut off all the air; then by moving the handle still further in the same direction, the piston is lowered, which permits the full air pressure to be applied to the work. If the pressure thus obtained does not prove to be sufficient, a further movement of the controlling handle in the same direction throws into operation a small, quick-acting air pump, which is placed on the top of the upper frame, but is not shown in the illustration. This pump is capable of raising the pressure to 250 pounds, when the main line is supplied with air having 80 pounds pressure to the square inch. The valve allows a very sensitive adjustment of the piston in either direction, and is so arranged that the piston cannot move too rapidly.

## 16-INCH PORTABLE LATHE.

The 16-inch portable lathe, illustrated herewith, was designed by the Lodge & Shipley Machine Tool Company, Cincinnati, Ohio, for use in fitting frame bolts, turning studs, etc., in locomotive repair shops. The machine can be wheeled alongside the locomotive, upon which the work is to be done, and a considerable saving in time and strength can be effected over the practice of carrying the parts to be fitted to the lathe department. An 18-inch lathe used for this purpose at the Collinwood shops of the Lake Shore & Michigan Southern was described on page 91 of the March, 1907, issue of this journal and a 16½-inch portable lathe, used at the Angus shops of the Canadian Pacific Railway was described on page 35 of the January, 1908, issue.

The lathe bed is mounted on three wheels and may be pulled about by one man on a fairly level floor. The motor is of a 2½ h.p., fully enclosed, constant speed type and is suspended underneath the headstock and belted to a two-step cone pulley, mounted upon the back gear shaft. The class of work to be handled does not require a wide range of spindle speed and the



LODGE & SHIPLEY PORTABLE LATHE.

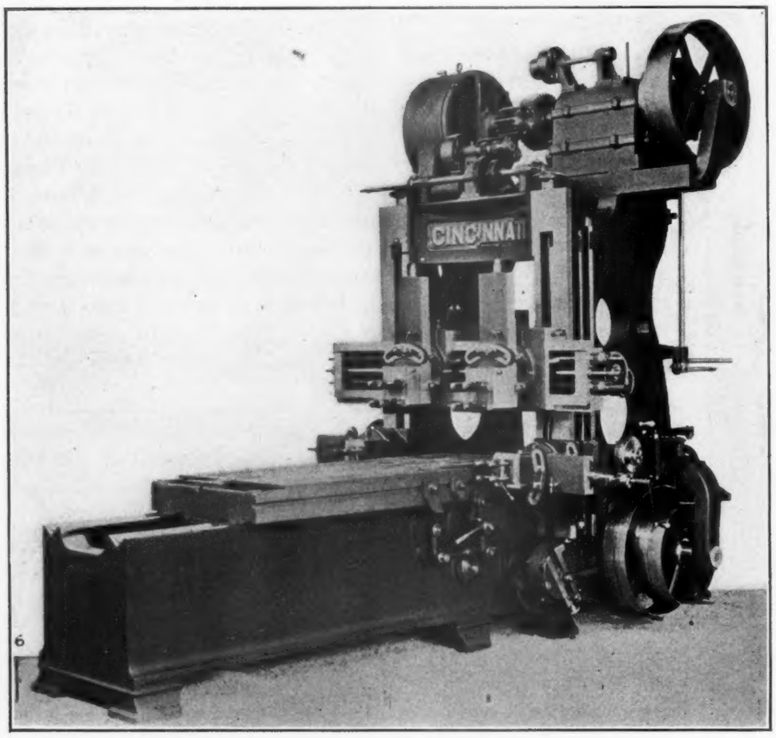
two changes, which are provided, are thought to be ample. The lathe is supplied with a belt feed of two changes, a power longitudinal feed and a plain rest. If desired it can be supplied with a taper attachment; legs can also be furnished in place of the wheels.

SIXTY-TWO STORY BUILDING.—Plans have been filed with the superintendent of buildings, of New York City, for a 62-story structure for the Equitable Life Assurance Society, to stand on the block bounded by Broadway, Nassau, Pine and Cedar streets. Including a tower, the building will rise to a height of 909 feet above the curb line, exclusive of a flagstaff, which will measure to the tip 150 feet more. The estimated cost is about $10,000,000. The design is by D. H. Burnham & Co., and shows that the main building will be of thirty-four stories or 489 feet, with a frontage of 167 feet on Broadway, 152 feet on Nassau street, 304 feet on Pine street and 312 feet on Cedar street. Above this building will rise a square tower of 28 stories capped with a cupola, the tower and cupola together to be 520 feet high. The main building is to be equipped with a group of thirty-eight passenger elevators built in two rows in a corridor finished in ornamental bronze. Eight of these will run to the top of the tower extension. No definite action has been taken as to just when the building will be erected.

## 37-INCH HEAVY VARIABLE SPEED FORGE PLANER.

The heavy forge planer, illustrated herewith, was exhibited at the Atlantic City conventions by The Cincinnati Planer Company, Cincinnati, Ohio. It was driven by a 15 h.p. constant speed motor which transmitted power to the speed box through a raw-hide pinion and a cast iron gear. The speed box furnished four changes of cutting speed, 20, 28, 35, and 45 ft. per minute, with a constant return speed of 80 ft. per minute. The speeds are changed by the vertical shaft and handles, shown at the right. The speed box is enclosed and all the gears run in oil.

The bed is made of extra length, so that there is very little overhang of the table when planing at full stroke. The V's are fitted with automatic roller oiling devices. The table is carefully designed for unusual strength and stiffness and is arranged with a dustproof feature which prevents the chips from falling into the V's. A complete shifting mechanism is furnished on both sides. A considerable improvement has been made in the tumbler, the surfaces of the tumbler and dog which come in contact, being designed so that these parts roll, instead of slide on each other. Wear on these parts is thus practically eliminated.




CINCINNATI 37-INCH HEAVY FORGE PLANER.

The housings, of heavy box construction, are carried down to the bottom of the bed and are fastened to it by heavy bolts and dowel pins; in addition they are secured to it by a long tongue and groove. They are tied at the top by the heavy box-shaped arch. The cross rail has large bearings on the housings and is stiffened by an arch-shaped brace at the rear. It is of sufficient length to allow either one of the two heads to traverse the full width of the table. The heads are of a new shape, the end of the tool block and slide being made round to clear projecting corners on angular work. They are provided with taper gibs, and the slides are hung on ball bearings. The heads are made right and left, and are provided with automatic feed in all directions. Side heads are fitted on both housings, with independent power and hand vertical feed, and can be run below the top of table when not in use. The handles, which control the feeds, travel up and down with the heads and are therefore always convenient to the operator. The side head tool block, to which the planing tool is fastened, is fitted with a little handle for throwing out the spring which holds it down. The tool blocks on the rail heads fall back in place by gravity, but on the side heads it is necessary to use a spring to force them back in place. When they are moved out slightly on the return stroke, owing to the fact that it is frequently necessary to look at the tool or rub it up with an oil stone, it has been heretofore a little troublesome to pull them out on account of this spring; with this little handle it is only necessary to push the handle down and the tool block may be pulled out its full limit. Provision is made so that side heads may be attached to machines not equipped with them when purchased, at any future time. A patent elevating device is located at the center of the arch and provides a third bearing for the elevating shaft, distributing the pull equally. This device is driven by a belt connected to the pulley, mounted on the brackets above the speed box, which is in turn driven from the speed box shaft. Ordinarily the elevating device is driven direct from the speed box shaft, but the construction of this particular machine would not admit of doing this.

A combination friction insures positive feed when the heaviest cuts are being taken. The shifter is provided with a safety locking device to prevent the table from starting except at the will of the operator.

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THE REAL PURPOSE OF THE STORES DEPARTMENT.—First: To furnish material when and where it is wanted.

Second: To properly, promptly and economically care, handle and account for it.

Third: Proper inspection and check to see that the railroad gets what it buys.

Fourth: To maintain standards by seeing that the proper name and description is maintained.

Fifth: Classify and place requisitions far enough in advance and in such quantities as to enable the purchasing agent to make judicious purchases.

Sixth: Classify and order material in such quantities as to get the benefit of carload rates of freight.

Seventh: Finance resources by keeping material in as few places as possible, and in such shape that it is ready to move when required.

Eighth: Prompt and certain deliveries only in such quantities as are actually needed.

Ninth: Keep only a minimum amount of material on hand.—*H. C. Pearce before the Railway Storekeepers' Association.*

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LARGE FRENCH METAL WORKING PLANT.—The Creusot works of Schneider & Company in France occupy an area of about 3,300 acres and extend uninterruptedly for a distance of three miles. The different departments are connected by a system of railways 200 miles in length, with a rolling stock of 55 locomotives and 1,600 cars. The number of employees of all classes varies from 15,500 to 16,000. —*American Machinist.*

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**EXHAUSTION OF OUR COAL SUPPLY.—The exhaustion of our coal supply is not in the indefinite future. The startling feature of our coal production is not so much the magnitude of the annual output as its rate of growth. For the decade ending in 1905 the total product was 2,832,402,746 tons, which is almost exactly one-half the total product previously mined in this country. For the year 1906 the output was 414,000,000 tons, an increase of 46 per cent. on the average annual yield of the ten years preceding. In 1907 our production reached 470,000,000 tons. Fifty years ago the annual per capita production was little more than one-quarter of a ton. It is now about five tons. Estimates of coal deposits still remaining must necessarily be somewhat vague. The best authorities do not rate them at much over 2,000,000,000,000 tons. If coal production continues to increase as it has in the last ninety years, the available supply will be greatly reduced by the close of the century. Before that time arrives, however, resort to lower grades and sinking of mines to greater depths will become necessary, making the product inferior in quality and higher in price.—*James J. Hill before the Governors' Conference.***

## WHAT THE RAILROAD CLUBS WILL DO IN SEPTEMBER.

*Canadian Railway Club (Montreal).*—R. E. Johnson, of the Canadian Fairbanks Company, Montreal, will present a paper on "Gas Producer Plants," September 1st, at the Windsor Hotel. Secretary, Jas. Powell, P. O. Box 7, St. Lambert, near Montreal.

*Central Railway Club (Buffalo, N. Y.).*—W. H. Evans, master mechanic of the International Railway Company, will read a paper on "Electric Traction vs. Steam Railroad Operation," Friday, September 11th. This is also the date of the fall outing of the club. A boat trip will be taken down the Niagara River, leaving at 10 A. M., and dinner will be served on Grand Island at 2:30 P. M. The return boat will reach the city at 7 P. M. The regular meeting of the club will be held on the boat en route. Secretary, Harry D. Vought, 62 Liberty street, New York City.

**Iowa Railway Club (Des Moines, Ia.)*—Meets September 11. Secretary, W. B. Harrison, Union Station, Des Moines, Ia.

*New England Railroad Club (Boston).*—Next regular meeting Ocotber 13th. Secretary, George H. Frazier, 10 Oliver street, Boston, Mass.

*New York Railroad Club (New York City).*—Raffe Emerson, assistant engineer of methods, Atchison, Topeka & Santa Fe Railway, will present a paper on "Handling Locomotive Supplies; Value of Proper Handling of Supplies; Supply Costs and Accounting; Design of Items of Engine Equipments; Methods of Handling Supplies and Equipments; Results," Friday, September 18th, at the Engineering Societies Building, 29 W. 39th street. Secretary, Harry D. Vought, 62 Liberty street, New York City.

**Northern Railway Club (Duluth, Minn.).*—Meets September 25. Secretary, C. L. Kennedy, 401 West Superior street, Duluth, Minn.

*North-West Railway Club.*—This club, of Minneapolis and St. Paul, has discontinued its meetings for the present season.

**Railway Club of Pittsburgh (Pittsburgh).*—Meets September 25. Secretary, J. D. Conway, P. & L. E. R. R., Pittsburgh, Pa.

**Richmond Railroad Club (Richmond, Va.).*—Meets September 10. Secretary, F. O. Robinson, 8th and Main streets, Richmond, Va.

**Rocky Mountain Railway Club (Denver, Colo.).*—Meets September 8th. Secretary, M. M. Currier, Box 229, Colorado City, Colo.

*St. Louis Railway Club.*—Prof. L. E. Young, director of the School of Mines and Metallurgy, Rolla, Mo., will address the meeting, Friday, September 11th. The exact subject has not yet been announced. Secretary, B. W. Frauenthal, Union Station, St. Louis, Mo.

*Western Railway Club (Chicago).*—Arthur Hale, chairman of the car service committee of the American Railway Association, will address the club on Tuesday evening, September 15th. Secretary, J. W. Taylor, 390 Old Colony Bldg., Chicago, Ill.

*Subject for discussion apparently not yet determined as no reply was received from the secretary up to the time of going to press. It is assumed that there will be no change in the time of holding the regular meeting.

## UNIQUE ADAPTATION OF SHELBY TUBING.

At a banquet, recently given to the officials of the National Tube Company at Pittsburg, the dishes used were formed (not cast) from Shelby seamless steel tubing. As shown in the illustration, the material was hammered flat for the knife blade and spoon handles, was curved in or out for the bowls of the spoons

and for the plate and saucer, was left in its original shape for the napkin ring, was expanded at one end into several times its original diameter for the goblet, and was formed into a bell. It is said that over three hundred uses have been found for this tubing, and new uses are constantly being added.

## PERSONALS

R. E. Fulmer has been appointed master mechanic of the Tremont & Gulf Ry., with office at Eros, La.

The office of the superintendent of motive power of the Mexican National R. R. has been transferred from Laredo, Tex., to San Luis Potosi.

W. C. Hayes, superintendent of the Erie at Susquehanna, has been appointed superintendent of locomotive operation, with headquarters in New York.

H. E. Lind has been appointed storekeeper for the Erie R. R. at Susquehanna, Pa., vice T. H. Keffer, resigned. H. J. Ackworth succeeds Mr. Lind as storekeeper at Kent, O.

R. B. Smith has been appointed foreman of motive power and equipment of the Cincinnati, Lebanon & Northern Ry., at Rendleton, O., succeeding John Stutter, resigned.

William Henry, assistant master mechanic of the St. Louis & San Francisco R. R., at Memphis, Tenn., has been appointed master mechanic with headquarters at Sapulpa, Okla.

William Baird, general car inspector of the Chicago, Burlington & Quincy Ry., has been appointed shop superintendent at the Plattsmouth, Neb., shops, succeeding H. J. Helps, resigned.

W. Hamilton, acting locomotive foreman of the Grand Trunk Ry., at Palmerston, Ont., has been appointed locomotive foreman at Stratford, Ont., succeeding J. A. Mitchell, resigned.

J. A. Mitchell, locomotive foreman of the Grand Trunk at Stratford, Ont., has been appointed locomotive foreman of the Grand Trunk Pacific, with office at Rivers, Man.

C. E. Gossett, master mechanic of the Chicago, Rock Island & Pacific at Armourdale, Kan., has been appointed master mechanic of the Iowa Central, succeeding T. M. Feeley, resigned.

G. W. Taylor has resigned as division master mechanic of the Atchison, Topeka & Santa Fe Ry., at Newton, Kan., to become superintendent of motive power of the San Antonio & Aransas Pass Ry., with headquarters at San Antonio, Tex., succeeding G. W. Butcher, resigned.

J. H. Munro has been appointed locomotive foreman of the Canadian Pacific Ry. at Muskoha, Ont.

George Wagstaff, supervisor of boilers of the New York Central Lines, has resigned, effective September 1, on which date he will take service with the Railway Materials Co., of Chicago.

G. H. Davis, master mechanic of the Clarendon & Pittsford R. R., has been appointed general foreman of the car department of the Wabash Pittsburg Terminal, with headquarters at Rook, Pa.

E. V. Lea, instructor of apprentices at the Hornell, N. Y., shops of the Erie R. R., has been appointed assistant supervisor of apprentices of the entire Erie system, with headquarters at Meadville, Pa.

H. H. Hale, superintendent of motive power of the Nevada Railroad, has been appointed master mechanic of the Gulf & Ship Island Ry., with headquarters at Gulfport, Miss., succeeding W. J. Haynen, resigned.

W. B. Russell, assistant superintendent of apprentices of the New York Central Lines, has resigned to accept a position as director of the new technical school in Boston, known as the Franklin Union. Benjamin Franklin left 1,000 pounds to Boston and 1,000 pounds to Philadelphia, to be on interest for one hundred years, at the end of which time it was to be used for some public purpose. The money in Boston has been used for an industrial school, the building of which cost $375,000. The city provided the land and Andrew Carnegie presented an amount equal to the Franklin fund for an endowment to run the school. It is to be equipped as an industrial school and to run with evening classes for mechanics and others working during the day time. The school is a combination of Cooper and Mechanics' Institutes, New York, and Pratt Institute, Brooklyn, adapted to the special needs existing in Boston and vicinity. It will represent the very latest thing in industrial education. Henry Gardner, apprentice instructor at the McKees Rocks shops of the Pittsburgh & Lake Erie R. R., has been promoted to succeed Mr. Russell on the New York Central Lines.

## POOR'S MANUAL FOR 1908.

Poor's Manual for 1908 (forty-first annual number) is issued. Although the work appears some two months earlier than last year and five months earlier than in 1906, yet it is as complete as ever, covering the 1907 fiscal year and calendar years, and containing information concerning the more important companies up to June 10, 1908.

An important feature of this edition is an enlarged industrial section embracing every prominent corporation in the United States from which a report could be obtained. Information is strictly up to date, and in the case of the larger companies include elaborate tables showing income accounts and balance sheets in comparative form for a series of years. In general treatment the industrial section compares favorably with the railroad section.

The total mileage of the steam railroads of the United States on December 31, 1907, was 228,128 miles, as against 222,766 miles on December 31, 1906, showing an increase of 5,362 miles.

The total capital liabilities of the railroads, including stock, bonds and other indebtedness, was $16,501,413,069, showing an increase of $907,864,112. Of this increase $351,717,809 is represented by stock and the balance by bonds and other forms of indebtedness.

The following table shows assets and liabilities of all the steam railroads of the United States at the close of 1907:

| | 1907. | 1906. |
|---|---|---|
| Capital stock | $7,458,126,785 | $7,106,408,976 |
| Bonded debt | 8,228,245,257 | 7,851,107,778 |
| Other bond obligations | 815,041,027 | 636,032,203 |
| Accrued liabilities | 94,938,347 | 86,218,524 |
| Miscellaneous liabilities | 75,450,828 | 124,319,942 |
| Bills payable and col'c't accounts | 857,734,167 | 722,023,502 |
| Sinking funds, etc. | 239,727,545 | 242,256,471 |
| Profit and loss | 789,617,481 | 686,919,232 |
| Total liabiliites | $18,558,881,437 | $17,455,286,628 |
| Cost of railroad and equipment | $13,364,275,191 | $12,719,736,342 |
| Stocks and bonds owned | 2,884,031,173 | 2,544,368,852 |
| Real estate and other investments | 738,843,199 | 761,413,476 |
| Cash, bills rec. and col'c't acc'ts | 979,730,908 | 941,399,320 |
| Materials and supplies | 224,237,534 | 182,635,253 |
| Other assets | 208,171,082 | 128,591,860 |
| Sinking funds | 159,592,350 | 177,141,525 |
| Total assets | $18,558,881,437 | $17,455,286,628 |

Gross earnings of the railroads reporting earnings for 1907, embracing 225,227 miles, amounted to $2,602,757,503, as compared with $2,346,640,286 in 1906, showing an increase of $256,117,217, or nearly 11 per cent. Net earnings from operation in 1907 were $833,839,600, as against $790,187,712 in 1906, showing an increase of $43,651,888, or about 5½ per cent. In 1906 net earnings had shown an increase of more than 15 per cent.

The following table shows the income account of the American railway systems for the year 1907, as compared with 1906:

| | 1907. | 1906. |
|---|---|---|
| Miles of railroad operated | 225,227 | 220,633 |
| Passenger | $574,718,578 | $521,231,337 |
| Freight | 1,825,061,858 | 1.659.925.643 |
| Other | 202,977,067 | 165,483,306 |
| Total gross earnings | $2,602,757,503 | $2,346,640,286 |
| Operating expenses | 1,769,417,903 | 1,556,452,574 |
| Net earnings | 833,339,600 | 790,187,712 |
| Other receipts | 128,015,081 | 100,292,369 |
| Total net income | $961,354,681 | $890,480,081 |
| Taxes | 74,253,245 | 68,169,833 |
| Interest on bonds | 280,931,001 | 269,926,395 |
| Other interest | 23,759,329 | 13,107,169 |
| Dividends on stock | 247,258,219 | 225,601,245 |
| Miscellaneous | 75,176,725 | 79,806,024 |
| Rentals—interest | 38,188,406 | 39,612,179 |
| Dividends | 31,087,374 | 27,739,680 |
| Miscellaneous | 18,127,456 | 15,042,783 |
| Total payments | $788,781,755 | $739,005,308 |
| Surplus | $172,572,926 | $151,474,773 |

*Traffic Statistics.*

| | | |
|---|---|---|
| Miles of railroad operated | 225,227 | 220,633 |
| Revenue train mileage: | | |
| Passenger | 511,579,317 | 488,554,209 |
| Freight | 645,447,465 | 608,324,539 |
| Mixed | 27,211,527 | 27,711,651 |
| Total | 1,184,238,309 | 1,124,590,399 |
| Passengers carried | 885,724,314 | 815,774,118 |
| Passenger mileage | 28,370,247,819 | 25,842,462,029 |
| Revenue per passenger-mile, cents | 2.040 | 2.011 |
| Tons freight moved | 1,722,210,281 | 1,610,099,829 |
| Freight mileage | 233,137,507,807 | 216,653,795,696 |
| Revenue per ton-mile, cents | 0.782 | 0.766 |

## BOOK NOTES.

Bulletin of Foundry Information. Volume 6. Bound in cloth. 160 pages. Published by The S. Obermayer Co., Cincinnati, O. Price, 60 cents.

This book consists of a year's issue of the *Obermayer Bulletin of Foundry Information,* which includes much information of value to foundrymen. The articles are written by men thoroughly familiar with their subjects and are strictly practical.

Binders for Coal Briquets. Report of investigations made at the fuel testing plant, St. Louis, Mo. By James E. Mills. Bulletin No. 343 of the United States Geological Survey, Department of the Interior, Washington, D. C. Can be obtained upon request.

This bulletin goes into the subject of binders for briquets in great detail and gives the results of the very valuable experiments which were made along these lines at the government's testing plant at St. Louis.

Reinforced Concrete. A Manual of Practice. By Ernest McCullough. 4½ x 7½ in.; 124 pages; illustrated. Published by the Cement Era Publishing Co., 842 Monadnock Block, Chicago, Ill. Price, $1.00.

This book is written for men not technically educated and gives practical instructions in the proper methods of procedure in the design and location of forms and the placing of the concrete. There is also some space given to the theoretical treat-

ment of reinforced concrete structures, all of which is, however, explained in simple language.

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The Plane Table. By W. H. Lovell, Topographer, U. S. Geological Survey. Cloth. 47 pages. 4½ x 7¼. Illustrated. Published by the McGraw Publishing Co., 239 W. 39th St., New York. Price, $1.00.

The plane table is one of the oldest of surveying instruments and possesses obvious advantages as regards speed, economy, convenience and adaptability for surveying purposes, but has been used to a very limited extent in this country. This small book points out the way in which this instrument can be made of greater value to surveyors.

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Steel Car Design. By A. Stucki. 23 pages, 7 x 10, illustrated. Published by the author, Room 617, Farmers' Bank Building, Pittsburg, Pa. Price, $2.00.

Mr. Stucki has had a number of years' experience in the engineering departments of two of the large steel car companies, in addition to considerable actual railroad experience. The book consists of a reprint of a series of articles published in the *Railroad Gazette* during June and July, 1904. It is not intended to give a complete and absolutely accurate analysis of the stresses in steel cars, but consists of extracts from Mr. Stucki's note book based on his experience in designing and building cars and data from the testing laboratory.

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Hand Book of Mathematics for Engineers. By L. A. Waterbury. Vest pocket size. 90 pages. Flexible leather cover. Published by John Wiley & Sons, 43 E. 19th street, New York. Price, $1.00.

This hand book is intended as a reference book for the use of those who have studied, or are studying, the branches of mathematics usually taught in engineering courses. It is not intended as a text book and therefore does not attempt to prove any of the formulæ which are given. The different subjects treated in this book are, algebra, trigonometry, analytic geometry, differential calculus, integral calculus, theoretical mechanics and mechanics of materials, the last being the largest section and covering the subject in all of its more important features.

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Up-to-Date Air Brake Catechism. By Robert H. Blackall. Twenty-third edition. Revised and enlarged. 373 pages. Cloth. Illustrated. Published by the Norman W. Henley Publishing Company, 132 Nassau street, New York. Price, $2.00.

The improvement in air brake apparatus is so constant and important that necessarily any book which pretends to cover the subject thoroughly must be continuously revised and enlarged. A good example of this is the book under consideration, which was first brought out ten years ago, is now in its twenty-third edition, and has been revised five or six times during that period. It is undoubtedly the most complete and accurate work on the Westinghouse air brake system obtainable and, being arranged in catechism form, is of particular value to trainmen and others who are compelled to take examinations in this subject.

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How to Become a Competent Motorman. By Virgil B. Livermore and James R. Williams. Second Edition; revised; 4½ x 6¼ in.; 247 pages; illustrated. Published by D. Van Nostrand Co., 23 Murray street, New York. Price, $1.00.

This book is written by two practical men who, by actual experience, have learned just which things a competent motorman must know. It deals with the subject in an elementary manner, being fully illustrated with half-tones of apparatus and diagrams of connections. It includes descriptions and instruction on the air brakes used on electric equipment, as well as considerable matter on signaling. Each section of the book contains a series of questions and answers such as would ordinarily be asked in an examination on the subject.

Notes on Hydro-Electric Developments. By Preston Player. 65 pages. 4½ x 7¼. Cloth. Published by the McGraw Publishing Company, 239 W. 39th St., New York. Price, $1.00.

This book confines itself to a consideration of the commercial side of the utilization of water power. Its primary object is to indicate, as far as possible, the information which should be obtained in order to afford a definite basis for forming a decision as to the merits of any proposed undertaking. The subject from this standpoint is treated clearly and accurately, and points out the exact conditions under which a certain proposition will or will not be profitable.

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The Hill Kink Books. Compiled by F. H. Colvin and F A. Stanley, associate editors of *The American Machinist.* Published by the Hill Publishing Company, 505 Pearl St., New York City. 4 x 6 in. Illustrated. About 100 pages each. Cloth bound. Price, 50 cents each.

There are ten of these little volumes as follows: Drill Press Kinks; Tool Makers' Kinks; Screw Thread Kinks; Jig and Fixture Kinks; Drawing Room Kinks; Patternmaking Kinks; Milling Machine Kinks; Screw Machine Kinks; Press Tool Kinks and Repair Kinks. The information has been carefully selected from the columns of *The American Machinist;* the editors make no pretense of trying to treat each subject exhaustively, but have tried to place within convenient reach of mechanics and draftsmen out of way information which it would be otherwise difficult to find quickly, or at all.

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National Society for the Promotion of Industrial Education. Bulletin No. 5. Proceedings of the First Annual Meeting, Chicago; Part 1. Copies may be obtained by addressing the Secretary at the office of the Society, 546 Fifth avenue, New York City. Price, ten cents.

This bulletin contains the following addresses: "Industrial Education as an Essential Factor in Our National Prosperity," by Charles W. Elliott; "Industrial Education from the Standpoint of the Manufacturer," by James W. Van Cleave; "The Aims of the National Society for the Promotion of Industrial Education," by Henry S. Pritchett; "The Apprenticeship System as a Means of Promoting Industrial Efficiency," by Carroll D. Wright; "The Apprenticeship System of To-day," by W. R. Warner; "The Value of a Thorough Apprenticeship to the Wage Earner," by W. B. Prescott; "Trade Instruction in Large Establishments," by J. F. Deems, and "The Necessity of Apprenticeship," by Leslie W. Miller.

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The Railroad Signal Dictionary. By Braman B. Adams and Rodney Hitt. 9 x 12 in.; 514 pages; 3,120 engravings. Published by the Railroad Age Gazette, New York, Chicago, Pittsburg and London. Bound in morocco. Price, $6.00.

The editors prepared this dictionary under the supervision of a committee of the Railway Signal Association. They thus had the benefit of all the resources of that association, also of the co-operation of the leading manufacturers of the country and of the *Railroad Age Gazette* office. The dictionary in many respects is similar to the car builders' and locomotive dictionaries, except that it is necessarily more complete in the description of processes and methods, because of the less advanced state of the art of signaling and its rapid development. The illustrations of every important machine or piece of apparatus are accompanied by a carefully prepared description of its working. It forms a complete and up-to-date treatise on signal engineering and is invaluable to anyone interested in that subject.

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Railway Signaling. Written by a staff of expert signal engineers. 108 pages. 6 x 9. Cloth. Illustrated. Published by the Electric Journal. 422 6th Ave., Pittsburg, Pa. Price, 75 cents.

Anyone who has attempted to post himself on modern signaling apparatus has been greatly hampered by the lack of literature which shows the more recent and up-to-date appliances. The *Electric Journal* realized this condition and obtained a series of

articles from the engineers of the Union Switch and Signal Co., which ran serially. These articles have been put into book form and describe the various principles of operation and types of apparatus in a manner which places the information within the reach of the ordinary laymen. The book is thoroughly illustrated with half-tones and line drawings. It is divided into nine chapters, as follows: Mechanical Interlocking; Electro-Pneumatic Interlocking; Electric Interlocking; The Electric Train Staff System; Automatic Block Signaling; Automatic Block Signaling—Direct Current; two chapters on Automatic Block Signaling—Alternating Current; The Language of Fixed Signals.

## CATALOGS WANTED.

F. H. Ely, chief engineer of the Corning, Keuka Lake and Ontario Railway Company, with offices in the Hudson Terminal Building, New York City, desires to secure catalogs of all classes of railway equipment, rolling stock, etc.

## CATALOGS

IN WRITING FOR THESE PLEASE MENTION THIS JOURNAL.

GISHOLT TOOLS.—The Gisholt Machine Company, Madison, Wis., is issuissuing a small size catalog containing 72 pages, which very completely illustrates and briefly describes the large variety of tools manufactured by it. This catalog will be found to be very convenient for ready reference.

STEAM TURBINES.—The Terry Steam Turbine Company, Hartford, Conn., is issuing a catalog illustrating and describing its type of turbine for driving dynamos, pumps, blowers, shafting, or machinery. The details of the construction are clearly illustrated and photographs of direct connected units of various kinds are shown.

COLLEGE OF ENGINEERING, UNIVERSITY OF ILLINOIS.—Bulletin No. 14 of the University of Illinois, Urbana, Ill., consists principally of a number of most interesting photographs, showing the buildings and equipment of the College of Engineering of that University. A brief mention of the purposes of the ten different courses, given in this college, is also included.

GRAPHITE.—An interesting booklet has been received from the Joseph Dixon Crucible Company, Jersey City, N. J., entitled "Dixon's Ticonderoga Flake Graphite." It presents a brief discussion concerning graphite and its formation, and its value as a lubricant under different conditions of service. Copies of this booklet may be secured by writing direct to the Dixon Company.

AIR BRAKE INSTRUCTION BOOKS.—Instruction Book No. 5034, from the Westinghouse Air Brake Company, Pittsburg, Pa., describes in detail the construction and operation of the type L triple valve. Instruction pamphlets Nos. T-5037 and T-5035, from the Westinghouse Traction Brake Company, Pittsburg, Pa., describe respectively No. 12 EL locomotive brake equipment and its operation and the AMS brake equipment and its operation.

ASBESTOS AND MAGNESIA FOR RAILROADS.—The H. W. Johns-Manville Co., 100 William street, New York, is issuing catalog No. 251, which is devoted to illustrating and describing the great variety of asbestos and magnesia products which are used on railroads. The catalog contains 180 pages and covers very fully practically all products of this kind which find a use for lagging pipes and boilers; packing flange joints, piston rods, etc.; cementing pipes; pipe and other gaskets, pump valves, etc.

HART CONVERTIBLE CARS.—The Rodger Ballast Car Company, Railway Exchange, Chicago, Ill., is sending out a booklet known as the reference book of 1908. It describes and illustrates, both with line drawings and half-tone reproductions, the Hart convertible car which is adapted for construction and maintenance purposes, and also as a general service gondola car. A number of convertible box and stock cars, flat cars, side dump cars, work cars and special cars are also illustrated.

WALSCHAERT VALVE GEAR.—A pamphlet on this subject recently issued by the American Locomotive Company contains a paper read by C. O. Rogers, traveling engineer of the company, before the eighth biennial convention of the Brotherhood of Locomotive Engineers, at Columbus, Ohio, May, 1906. The purpose of the paper was to explain in a simple and plain manner the principle, action, and construction of the Walschaert valve gear, and the difference between it and the Stephenson link motion. One section, that containing suggestions and recommendations regarding what to do in case of breakdowns on the road, will in particular be of value to those operating engines equipped with this type of valve motion. A number of illustrations of engines, disconnected and blocked as recommended, are given to assist in a clear understanding of the text. A copy of the pamphlet will be mailed upon request.

STEAM GAUGES.—The American Steam Gauge and Valve Mfg. Co., 220 Camden street, Boston, Mass., is sending out a 120-page, standard size, catalog, which most thoroughly illustrates and describes the different lines of gauges made by them. In this catalog will be found a number of new arrangements and designs of gauges and allied apparatus. Calorimeters, thermometers, whistles, pyrometers and water columns are also given brief mention.

ELECTRICAL APPARATUS.—The General Electric Company is issuing a number of new bulletins on various subjects, among which might be mentioned number 4597 on astatic switchboard instruments for continuous current. These instruments have no controlling springs and their accuracy is not affected by the changes of magnetic strength. No. 4575 describes type F form K7 oil switch, which has been designed to meet the requirements of induction motor installations. No. 4596 deals with the subject of globes for arc lamps. In addition to these a small circular, No. 3664, is being sent out which describes a new locking socket for preventing the removal of incandescent lamps by unauthorized persons. Due to the rapidly extending use of tantalum and other expensive lamps a socket of this kind is becoming a necessity.

ALUNDUM.—A booklet of this title, published by the Norton Company, Worcester, Mass., tells in an interesting way of the various steps in the manufacture of this material. Alundum is used solely in the manufacture of Norton grinding wheels, and that it has given satisfactory service is indicated by the fact that in 1907 six million seven hundred and fifty thousand pounds were manufactured as against two hundred thousand pounds in 1901. Alundum is made by fusing bauxite in the intense heat of an electric arc furnace. This mineral is found in its purer forms in Georgia, Alabama and Arkansas, and the Norton Company controls its own supply from mines in these states. The bauxite is converted into alundum in the company's electric furnace plant at Niagara Falls and this is made into the finished product at the works in Worcester, Mass.

The booklet closes with a consideration of the properties possessed by alundum, which make it so satisfactory for grinding purposes, and directs forcible attention to the fact that the grade of the wheel should be adapted for the work which it is to do.

## NOTES

PITTSBURGH EMERY WHEEL CO.—This company has just finished an order of 55 emery wheels which have a 26 in. width of face. This is an exceedingly difficult proposition for manufacture and is the second order of this kind which has been successfully completed by this company.

AMERICAN LOCOMOTIVE COMPANY.—This company has recently received orders from the Central Northern Railway of Argentine for ten 10-wheel freight locomotives and twenty Pacific type passenger locomotives; also from the Eastern British Columbia Railway Company for two consolidation freight locomotives.

AMERICAN STEAM GAUGE & VALVE CO.—E. H. Smith, formerly master mechanic of the Boston & Albany R. R., has accepted the position of railroad representative for the American Steam Gauge & Valve Manufacturing Company. He will make his headquarters at the company's general offices, 220 Camden street, Boston.

NEW BUILDINGS AT THE UNIVERSITY OF ILLINOIS.—A contract for a new building, forming part of the College of Engineering, and which will be occupied wholly by the Department of Physics, has recently been let by the trustees of the University of Illinois. This building with its equipment will cost $250,000 and is to be known as the Physics Building.

WAREHOUSE FOR THE S. OBERMAYER COMPANY.—The constantly increasing trade of this company in and around Erie, Pa., has made it necessary to open a branch warehouse in that city. Mr. W. L. Scott is in charge, and a full line of foundry facings, core compounds, plumbago and blackings will be carried for the present; just as soon as conditions warrant, a complete line of other foundry facings and foundry supplies will be carried in stock.

GOLDSCHMIDT THERMIT COMPANY.—This company, of 90 West street, New York, is building a new machine shop and foundry, 34 x 90 feet in size, just back of the present factory in Jersey City. It is to be fitted up for the purpose of handling the extensive repair work, which is now being carried on at these works, to better advantage. Special attention will be paid to the rapid execution of the repairs to any wrought iron and steel sections not exceeding 2,000 pounds in weight.

FRENCH BRILL COMPANY ORGANIZED.—Compagnie J. G. Brill, 14 Place de Laborde, Paris, France, has been organized to handle the business of the J. G. Brill Company, Philadelphia, in France and Spain. A plant is to be established and the Brill trucks for those countries will be built by French workmen under French supervision and with French machinery. Brill trucks and equipment have become very popular throughout these two countries and it is believed that this business can be better handled by a complete plant in France.

# CARE OF BOILERS AT TERMINALS

By J. F. Whiteford.*

One of the most perplexing problems that confront the operating department and especially the mechanical officials, is the handling of engines at terminals. When it is considered that fully thirty per cent. of the life of a locomotive is spent at roundhouses, as compared with eight per cent. at repair shops, and that roundhouse repairs constitute forty-five per cent. of their maintenance, the urgent need of adequate facilities and improved methods becomes very apparent, and the necessity of roundhouse improvements seems of more vital importance than repair shop facilities.

With the development of the locomotive to its present state of efficiency, the care of the boiler has become the most important item in roundhouse work, though investigation reveals the fact that, either through ignorance on the part of those handling this class of work, or lack of proper facilities, boilers are often tortured to the extreme. Economical operation demands that this question be given the utmost consideration and that not only proper tools and facilities be provided, but that proper methods be employed and efficient supervision installed to prevent the continuance of abuses that have become standard through extended practice.

The difference of opinion of those directly responsible for boiler performance, as to the proper methods to pursue, has in many instances proven a great obstacle in improving the service, and the real problem devolves upon those in immediate charge of the work, leaving them to use their own judgment in the matter, however correct or faulty it may be; the boiler suffers in consequence.

The differences in boiler design and specifications of boiler material are sufficient evidence as to the variation of opinions held and indicate the difficulty in outlining a method of handling boilers that will be entirely satisfactory to all concerned.

While the subject of boiler repairs is one which is deserving of much study, the writer has left this item for further consideration and wishes to direct special attention to the washing of boilers and to present views as to the best methods, deduced from careful experiment and continued investigation.

All authorities on metallurgy agree that when non-tempering steel is subjected to a change in temperature that the best results are obtained when care is taken to insure the heating or cooling to be as uniform as possible. Boiler men hold the same opinion, especially as applied to the annealing of fire box sheets previous to their application, and since it is essential to maintain a uniform temperature in handling a plate independently, it appears to be even more essential to do so after it has become a part of a locomotive boiler, where limitations of dimensions are such as to necessitate a very rigid construction, and internal strains induced by unequal temperatures will be unusually severe. It therefore becomes evident that the best method of handling boilers at terminals is the one wherein the temperatures of the various portions of the boiler are maintained uniform or nearly so; the accompanying charts illustrate the temperature variations during different operations.

For this purpose, several high grade thermometers were placed in various parts of the boiler and readings were taken simultaneously. As it was found that the temperatures were almost identical on the same levels, the charts include only those showing the temperatures at the crown sheet (Thermometer No. 1) and the mud ring (Thermometer No. 2), thus indicating the variation in temperatures in a vertical distance of forty-four inches.

Much has been written relative to damage resulting from the use of injectors when the engine is standing still. Exhibit A serves to give additional data on this point, since it shows the variation in temperatures resulting from the use of the injector while an engine was standing on the ash-pit track, awaiting its turn to be taken to the house. The rapid drop of the bottom thermometer to a point 112 degrees lower than the top one during a period of sixteen minutes is sufficient evidence to indicate that the care of a boiler at a terminal must begin immediately upon its arrival, more especially since the class of labor usually employed on this work fails to realize sufficiently the necessity of prompt handling.

Designers of terminals who neglect to provide adequate facilities for the elimination of ash-pit delays, even during periods of congestion, overlook a very important feature in economical operation, as provision should be made to handle engines promptly. The fire should either be knocked or cleaned, as the needs of the service require. It is very difficult to herd engines with dirty fires and the system of having engines cross the ash-pit in the order of their arrival permits a more efficient organization and tends to decrease boiler repairs.

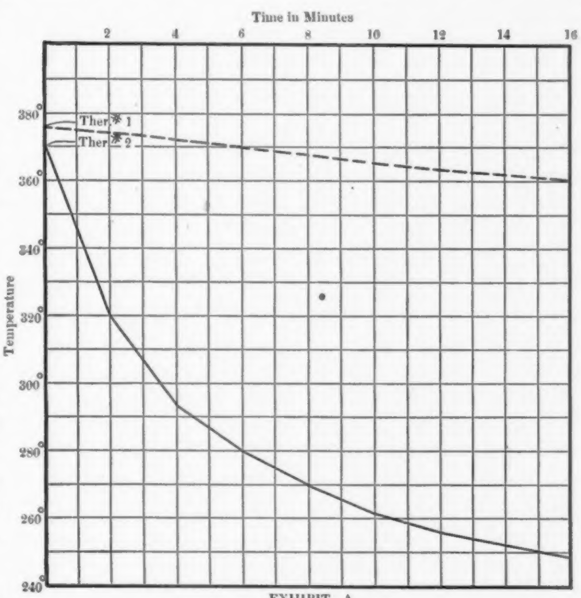



EXHIBIT A

VARIATION IN BOILER TEMPERATURES RESULTING FROM USE OF INJECTOR WHILE ENGINE WAS STANDING ON ASH PIT TRACK AWAITING ITS TURN TO BE TAKEN INTO THE ROUNDHOUSE.

The cooling of a boiler preparatory to the washing or changing of the water is the next important operation and charts are given showing the temperatures during the cooling by the following methods:

Exhibit B—Cooling with 60 degree water.

Exhibit C—Cooling with 125 degree water.

Exhibit D—Blowing out without cooling.

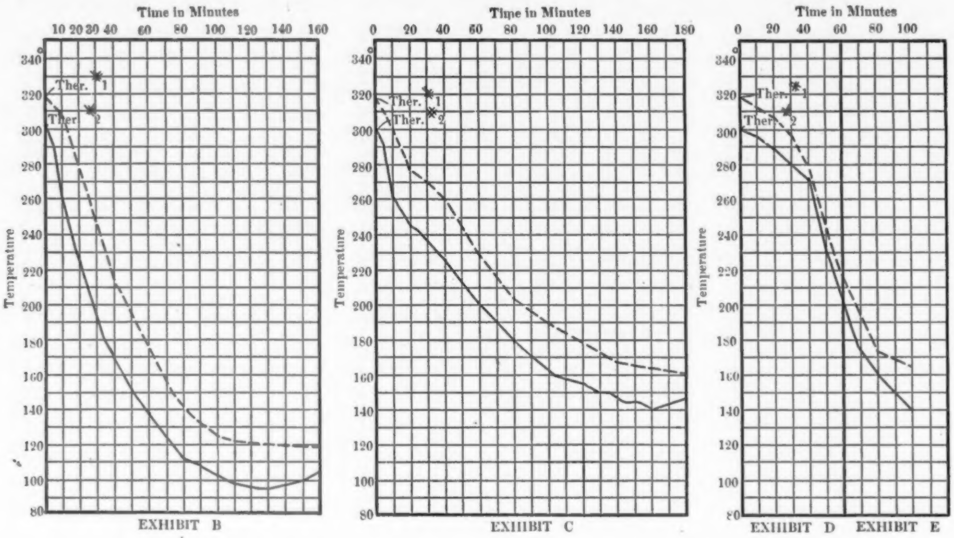
In all cases, the pressure was reduced to 75 pounds by blowing the steam off through a dome connection into an overhead line, and the cooling water in both Exhibits B and C was introduced through the branch pipe and injector throttle.

With the introduction of 60 degree water for cooling purposes (Exhibit B), a comparatively even and gradual reduction in temperature was realized, the maximum difference in the readings being 62 degrees at the twenty-minute line; the total time necessary to reduce the temperature from 320 degrees to 116 degrees was 160 minutes.

When water at 125 degrees was introduced (Exhibit C), the reduction in temperature was slightly irregular, though with less variation as compared with Exhibit B and considerably slower, since a total of 180 minutes elapsed in reducing the temperature from 315 degrees to 160 degrees with a maximum difference of 34 degrees at the forty-minute line.

In the third operation (Exhibit D), both blow-off cocks were opened and the contents of the boiler blown into a reservoir through suitable pipe, every effort being made to empty the boiler as rapidly as possible. The difference between the thermometers at the beginning was eighteen degrees, this gradually lessening to five degrees at the forty-minute line and continuing very near to that figure until the boiler was emptied, the temperature of both thermometers being approximately 210 degrees

* Member, American Society of Mechanical Engineers.




RESULTS OF COOLING THE BOILER UNDER DIFFERENT CONDITIONS: EXHIBIT B, WITH WATER AT 60 DEGS. F.; EXHIBIT C, WITH WATER AT 125 DEGS. F.; EXHIBIT D, BLOWING OUT WITHOUT COOLING.

at that time. This chart clearly illustrates that the least variation in temperatures is accomplished by simply blowing the contents out of the boiler as rapidly as possible and that the boiler is ready for washing fully ninety minutes earlier than by the method shown in Exhibit B.

In connection with this operation, Exhibit E is shown illustrating the temperature readings while the boiler was being washed with water heated to 125 degrees. It shows the rapid decrease of sheet temperatures during this operation, the variations remaining almost constant until near the close. The difference of twenty-five degrees between the thermometers at the one-hundred-minute line is due to the mud ring and lower portion of the fire box being washed last; the crown sheet temperature would not drop as rapidly in consequence.

Great care should be observed in taking the readings during this operation as the proximity of the washing nozzle to the thermometer will cause a temporary drop and readings should be taken so as to secure as nearly an average figure as possible.

The temperatures of the washing of the boilers are omitted in Exhibits B and C as the changes are comparatively slight and are not sufficient to enter into the discussion, while the length of time necessary in either of the three cases mentioned is dependent entirely on the condition of the boiler and need not be considered.

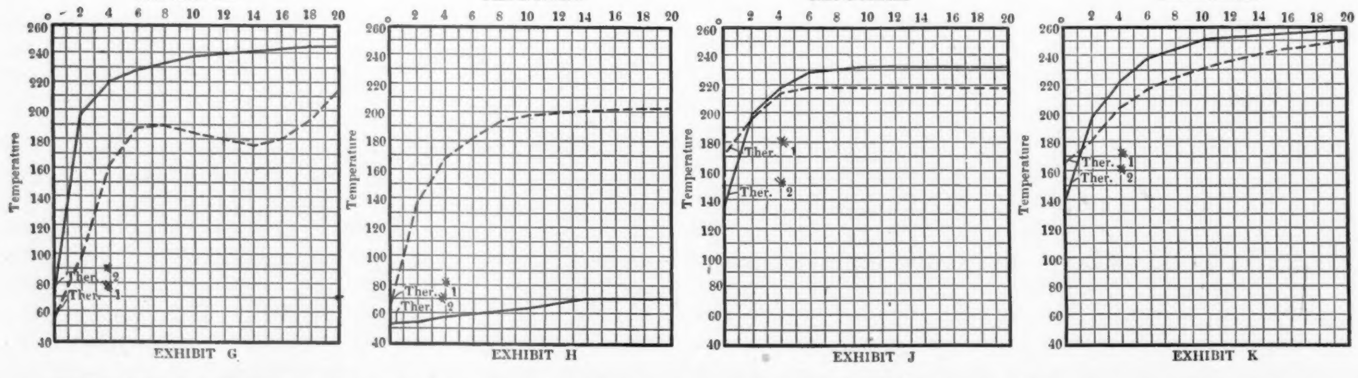
The results of experiments in connection with the filling of a boiler previous to firing are shown as follows:

Exhibit G—Filling cold boiler with 280 deg. water.
Exhibit H—Filling cold boiler with steam through dome.
Exhibit J—Filling warm boiler with 260 deg. water.
Exhibit K—Filling warm boiler with 280 deg. water.

For the purpose of comparison the charts cover a period of twenty minutes and are in most cases self-explanatory; special attention, however, is called to Exhibits G and H. In the former, where a cold boiler is filled with superheated water of 280 degrees temperature, the rise is very rapid to the six-minute line; a comparatively uniform condition follows though a drop in temperature of No. 1 is shown until a variation of 64 degrees is reached at fourteen minutes; this decreases rapidly thereafter. It should be noted that Thermometer No. 2 shows a more even temperature throughout; the crown sheet (Thermometer No. 1) remains at a much lower temperature than the mud ring during the operation.

Where a cold boiler is filled with steam through the dome (Exhibit H), a marked difference in temperature is shown between the crown sheet and mud ring, reaching 130 degrees at the eight-minute line and continuing throughout the operation. This chart is sufficient evidence against following this practice regardless of conditions, as the bottom portion of the boiler receives but little benefit with this method while admitting steam through the blow-off cock would cause excessive heating of the sheets in that vicinity.

Exhibits J and K illustrate the temperature changes when a warm boiler is filled with superheated water at 260 and 280 degrees temperature. While the charts at first glance apparently reflect a different condition, closer investigation shows that the results obtained are practically the same, as a comparatively slight difference in temperature is found in either case, though the extent of supply of superheated water and other influencing conditions will vary the temperature lines somewhat in either case. From these charts it may be readily seen that filling a boiler with superheated water at 260 or 280 degrees temperature gives a very satisfactory condition as regards uniformity of tem-




FILLING THE BOILER UNDER DIFFERENT CONDITIONS: EXHIBIT G, PUTTING WATER AT 280 DEGS. F. INTO A COLD BOILER; EXHIBIT H, FILLING A COLD BOILER WITH STEAM THROUGH THE DOME; EXHIBIT J, FILLING A WARM BOILER WITH WATER AT 260 DEGS. F.; EXHIBIT K, FILLING A WARM BOILER WITH WATER AT 280 DEGS. F.

perature, especially when the boiler is handled with sufficient rapidity so as to fill it before it cools to the temperature of the surrounding atmosphere.

The last and most important operation is that of firing up; the following charts illustrate the temperature lines during this period with varied conditions:

Exhibit L—Firing up with boiler filled with 60 degree water and no blower used.

Exhibit M—Firing as in Exhibit L, except blower used.

Exhibit N—Firing as in Exhibit M, except oil burning engine.

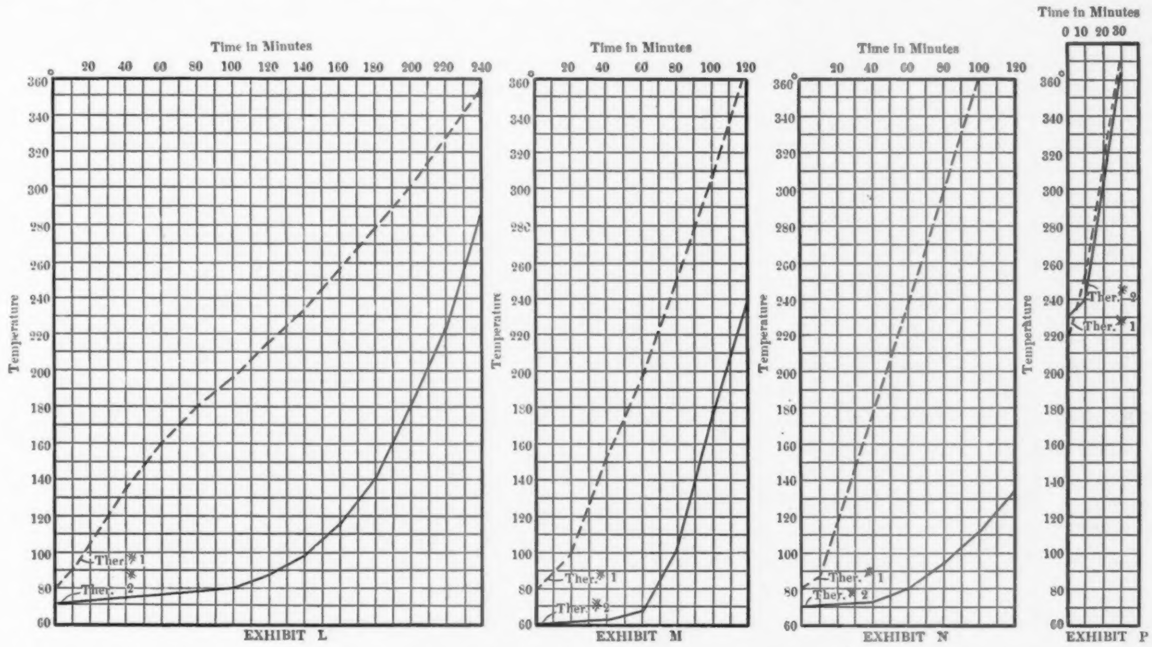
Exhibit P—Firing boiler filled with 260 degree water.

In these charts but little explanation is necessary with the exception that Exhibits L, M and P refer to coal burning locomotives and Exhibit N to an oil burner.

The extended periods where the variation in temperatures was over 120 degrees in Exhibits L and M, is worthy of much consideration as it indicates the internal strains that take place in a boiler during the firing up operation. While the variations are approximately the same in either case, it should be noted that where the blower was used (Exhibit M) and special effort was made to hasten the operation, that the duration was considerably inducing circulation throughout the boiler, the use of the accumulated pressure for this purpose minimizes the inequalities in temperature and consequently lessens the time necessary to complete the operation. This feature is of considerable importance, for if the water is superheated sufficiently, *i. e.*, to approximately 280 degrees, the regular house blower line can be dispensed with entirely.

The conclusions to be drawn from the foregoing experiments are that whatever means can be employed to hasten the handling of a boiler, the more efficient the service. The cooling down and firing up operations are the only ones necessary to consider and by studying Exhibits B and L, it will be noted that, by the cold water method, a variation from forty to sixty degrees exists in the first operation and from 100 to 140 degrees in the last operation; in both cases the period of unequal temperatures is quite extended; the total time consumed in performing these operations is 400 minutes.

By substituting Exhibit M for L, the total time for the two operations is reduced to 280 minutes, though the inequalities of temperature are much in evidence, the duration being considerably less through the use of the house and engine blower.




RESULTS OF FIRING UP UNDER VARIED CONDITIONS: EXHIBIT L, WITH THE BOILER FILLED WITH WATER AT 60 DEGS. F., NOT USING THE BLOWER; EXHIBIT M, SAME AS EXHIBIT L, EXCEPT THAT BLOWER WAS USED; EXHIBIT N, SAME AS EXHIBIT M, EXCEPT THAT THE ENGINE WAS AN OIL BURNER; EXHIBIT P, FIRING UP WITH THE WATER IN THE BOILER AT 260 DEGS. F.

less, the entire operation consuming 120 minutes against 240 minutes where no effort was made. This proves conclusively that it is an advantage rather than a disadvantage to hasten the firing operation, as a saving of time is accomplished and the period of inequalities of temperature is shortened considerably.

Exhibit N shows the temperatures during the firing up operation of a locomotive burning crude oil, in which case the blower was used and an effort was made to hasten the operation, the pressure being raised to 100 lbs. in practically 90 minutes. The extraordinary variation, reaching at times as high as 240 degrees, is largely due to the use of oil as a fuel and the arrangement of the brick work in fire boxes of this type, retarding circulation during this period.

The firing up of a boiler filled with superheated water at 260 degrees (Exhibit P) consumes from twenty-five to thirty minutes, during which time the temperature at the crown sheet raises from 222 degrees to 360 degrees, and at the mud ring from 230 degrees to 355 degrees, the variation of temperatures being less than ten degrees at all times.

In connection with this operation, it should be noted that when a boiler is filled with superheated water at a temperature of not less than 260 degrees, there should be an accumulated pressure when filling is completed to be utilized for blower purposes. As the use of the engine blower assists materially in

In the hot water process (Exhibits D and P), the variation in temperatures does not exceed ten degrees except for very brief periods and the total time consumed is ninety minutes, showing a saving in time of 190 minutes in cooling down and firing up over the cold water method and at the same time reducing the internal strains to a minimum.

The full advantages of the hot water method may be outlined as follows:

Reduction in time out of service.

Reduction of water and fuel consumed.

Reduction of labor cost.

Reduction of boiler repairs.

On the average, about 7,500 gallons of water are used in cooling a boiler as outlined in Exhibit B, and 2,500 gallons in washing the boiler. By arranging for the treating or filtering of the contents of the boiler after it has been emptied into a sump, the water can be used for the purpose of washing so that approximately 10,000 gallons of water can be saved for each washout. With the cost of water at five cents per thousand gallons, the saving will be comparatively small, though where the water supply is limited and reaches forty cents per thousand gallons, this feature will be of considerable importance.

Under the average conditions, the firing operation as shown in Exhibit M will consume about 3,000 pounds of coal and that

shown in Exhibit P will consume approximately 1,500 pounds, though both of these figures could be reduced somewhat by close application on the part of the employee. However, in the ordinary run, 1,500 pounds of coal will be saved at each operation, and assuming the value at $1.35 per ton, a net saving of $1.00 can be realized per engine.

Owing to the variation of operating conditions and the influence they exert upon boiler repairs, it is an exceedingly difficult matter to determine the exact decrease in repairs due to the use of a hot water system, or the net saving which results directly in this item. It is safe to assume that a 40 per cent. reduction in boiler repairs can be realized and that the mileage between shoppings can be increased fully 30 per cent. in many instances, though these figures must of necessity be modified to suit local conditions.

Though the conserving of water and the saving of fuel are items of some importance, as is the reduction in boiler repairs and decrease of boiler failures, neither of these items are deserving of consideration as compared with the reduction of the time out of service. To properly cool and wash and fire an engine with the cold water method, under the average conditions, will consume from six to seven hours, while the same operations with a hot water system can be completed in not to exceed two and one-half hours, resulting in a saving of time of fully four hours per engine. Assuming 600 boilers handled at a terminal in one month, a total saving of 2,400 hours can be realized, the monetary value of which can only be estimated by the needs of the service, though an average value of $3.00 per hour can be used for comparative purposes.

The cost of facilities for handling boilers in the manner just described depends largely upon the requirements and local conditions, but when the reduction of time in handling engines is considered, together with the saving of fuel and water and decrease in boiler repairs, it would be a profitable investment at any terminal handling an average of six boilers and over a day.

A reduction of time held at terminals permits the same tonnage to be handled over a division with less locomotives and also permits more engines to be handled with the same roundhouse capacity. This item is worthy of much consideration as the total expenditure for facilities of this nature would be considerably less than that needed to provide additional roundhouse room, where growth of business demanded it under the old conditions.

Where complete facilities are not provided, much improvement in service can be effected by providing two sumps, the foul water to be discharged into one for filtration, or treatment, and the filling water heated in the other by the live steam discharged from engines that are blown down. This would enable boilers to be washed with water at 125 degrees, or even at 150 degrees, as washing water at the last named temperature can be used if due care is exercised by those handling it. The filling water could be heated and delivered to the boiler at a temperature dependent on the amount of waste heat that could be utilized, but from observation, at almost any terminal there is sufficient to furnish this water at not less than 200 degrees. This arrangement would also permit the exhaust from pumps and similar machinery to be utilized and permit a higher efficiency as regards fuel at the entire terminal.

As stated in the beginning of this article, there is a considerable difference of opinion among boiler men as to the handling of boilers and the following objections have been offered against the use of the hot water method of washing:

The difference between the temperatures of the washing water and the sheets is so great as to be detrimental to the structure of the steel. Experiments with non-tempering steel have shown that the metal can be heated to a temperature of 1,200 degrees Fahr. and quenched without affecting the structure of the steel, which would indicate that a variation of 100 to 120 degrees temperature could be permitted within the limits of good practice.

Another objection is that with the sudden cooling, there is a tendency for the sediment to bake into a scale upon the sheets, which impairs the efficiency of the boiler. It does not appear as though this condition could exist to any extent as the washing operation should follow so close upon the blowing out as to prevent scale forming to any degree and the hot water should have the effect of softening the scale more than cold water.

The scouring effect produced by blowing out the boiler under pressure has a marked tendency to clear the boiler of sediment, rather than allow it to collect around the stays, which action should leave a cleaner boiler than by the cold water method, and is an important argument in favor of the rapid cooling practice.

As to what reduction in pressure, if any, should be made by drawing off the live steam from the dome previous to opening the blow-off cocks must be governed entirely by the arrangement of facilities and local conditions. The discharge of water carrying much sediment under high pressure will cause excessive wear on the piping and fixtures, adding materially to the cost of maintenance, though the pressure should be sufficiently high to produce the cleansing effect above mentioned.

The maintaining of uniform temperatures throughout the boiler, accomplished by the blowing down without cooling, the washing with water at a temperature between 125 and 150 degrees, and the filling with superheated water at not less than 260 degrees will result in better boiler performance and consequently more economical operation, and these benefits can be realized by the conserving of energy now wasted at many terminals.

## RAILROADS AND PROSPERITY.

The following is from an interview recently given by J. J. Hill to a New York *Herald* reporter:

"In no uncertain way have the railroads enabled us to make our country what it is to-day. They are pushing its prosperity and leading its progress as can no other single force. Yet, despite this record, they now are called upon to do the impossible. They are paying wages two and three times higher than the wage scales in other countries. They are employing equipment, in order to most effectively meet traffic demands, that costs one-third to one-half more than that used in other lands. They are facing constantly rising prices for materials. And, on the other hand, their rates are only one-third to one-half of the carrying charges of other countries—by far the lowest in the world. Our railroads have expended from $600,000,000 to $1,000,000,000 annually in recent years to improve their lines and keep them at the top notch of efficiency. The curtailment in business to-day is directly due to the curtailment of the buying power of the roads.

"In this contingency there is one step that must be taken if we are to have a return of general prosperity—freight rates must be moderately advanced. Justice demands that course and the best interests of the country at large require it. The alternative, the reducing of wages, is a dangerous expedient. Workmen need good wages to live properly. Cutting wages will not reduce the cost of living. Railroad operation requires good men. And the men who are handling the shuttling railroad trains today are the class of men upon whom the very life of this nation depends.

"If wages were cut there would be a breaking up of these organizations of loyal, earnest, dependable men, and many workingmen of sterling value would be lost. These men have a right to good wages. Surely it would be a dangerous expedient to step in and cut the wage scales in the face of the increased cost of living that controls to-day."

Effect of Water Soaking Timber.—Writers on wood seasoning mention the merits of lumber sawed from logs which have been submerged, directing special attention to the distinct advantages gained by soaking the logs or the sawed lumber in water, as a preliminary step to water seasoning. The United States Department of Agriculture advises that while soaking does decrease the tendency to warp it does not overcome the difficulty entirely. As a commercial practice it is not to be recommended except where it can be done during storage or transportation, because of the time required to produce results that fall far short of what is usually claimed.

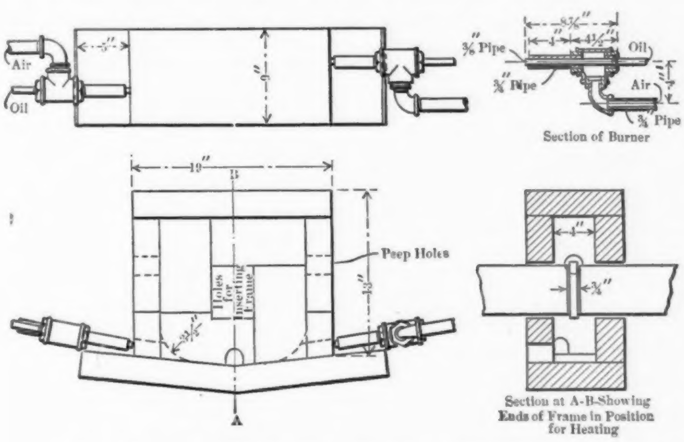
## WELDING LOCOMOTIVE FRAMES.*

By A. W. McCaslin.

On the Pittsburgh & Lake Erie Railroad we repair some of the engine frames, as many others do, without removing them from the engine and, as far as superficial examination of the completed job would indicate, we have very good results. I do not say that we weld these frames, for, like Mr. Uren, I do not consider that such an operation, made without a lap of some kind, deserves the name weld. In fact, this butting of frames is simply a burlesque on proper welding. I have satisfied myself as to the virtue of this so-called weld by making several in the shop, granting them many advantages that cannot be offered on an engine, and have found that they would invariably separate, showing very little resistance to a light crosswise blow under a small steam hammer. The breaks show that a union of the metal had been effected, but also show a very feeble tenacity; yet, knowing these facts, we are very much in favor of repairing frames this way, wherever it is possible to spread the frame and take the heat, as it frequently keeps the engine in service until the time comes for general repairs, and this means quite a saving.

We have what we think are splendid burners, and build a very satisfactory furnace with standard size fire brick. Mr. Shoenberger, foreman blacksmith in the Ft. Wayne shop at Pittsburg, kindly furnished me the original design for both of them. They are illustrated in the sketch. I build the furnace with the bottom inclined as shown on blue print, making it about 1 in. lower at its center than at the fuel holes at the ends. Have also added a small slag hole at the center near the bottom, so the slag will not gather and be blown up against the frame. We use two burners, and crude and carbon oil as fuel, and take a very slow heat. The bottom, inclined as mentioned, helps to prevent the wasting of the bottom side of the frame and gives the heat a start to return over the top of the frame and out the peep hole. When the heat is complete the furnace is pushed into the pit and the work completed with light sledges.

I do not approve of making the side V weld under a heavy steam hammer without using a channel tool. The work will be satisfactorily performed, however, if done under a small steam

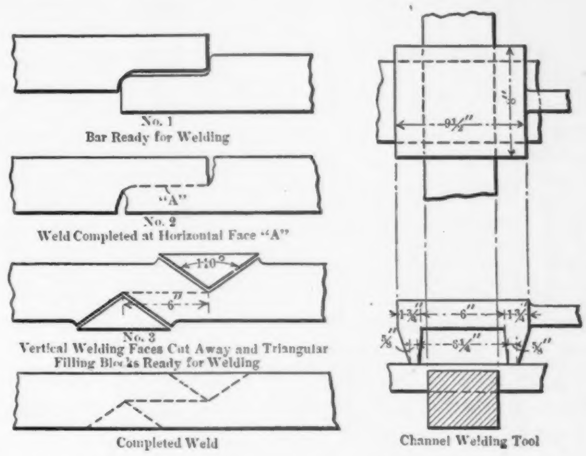



FURNACE AND BURNER FOR WELDING LOCOMOTIVE FRAMES.

hammer with light blows, or with heavy sledges. In this case the laid in piece should not be made with the overhang cut too close to the frame. Side heats should be drawn well up to the point of the V piece, and this stock driven back into the weld, at the same time a lap being formed where it is much needed, that is, at the ends of weld on the top and bottom of the frame.

If the side V weld is made in a frame under a heavy steam hammer there should be a heavy channel tool placed on top. This tool should be 8 in. wide, 2½ in. deep, and ½ in. longer in the crown, and ¾ in. longer at the mouth than the cross section of the frame, that it may release readily. It will shear off the extra stock, prevent the laid in piece from lengthening endwise, will drive it back into the weld, thus forcing it against the walls of the V, and lengthen the lap lengthwise the frame. A second heat should be taken on the laps, in order that there may be no hole or opening at the points of the weld. This is not only the most convenient weld to make in repairing frames, but it is the best.

We sometimes make, in front sections of frames and in large hammer piston rods, what we call a lap and V weld; we flatten the end of each piece nearly one-third, make the lap and weld




LAP AND V WELDS AND CHANNEL TOOL FOR HEAVY HAMMER WORK.

as shown on the sketch, then drive back the end of the laps and lay in a V; this insures a solid center and a solid side opposite each V. It also throws the laid in pieces about 6 in. apart. This weld will elongate evenly when being reduced and will not slip or shear as the ordinary lap or V weld will. The drawing clearly shows how this type of weld is made.

* From a paper presented at the recent meeting of the International Railroad Master Blacksmiths' Association.

LOCOMOTIVE REPAIR COSTS PER MILE.—In consequence of general shop inefficiency and operation inefficiency due to similar causes, locomotive repair costs on Western railroads run from $0.08 to $0.12 a mile; yet a most efficient superintendent of motive power on a large transcontinental road succeeded in dropping to $0.05 and had only touched the high spots, his well considered opinion being that $0.04 was reasonably attainable. On another transcontinental road, repair costs per mile were dropped from $0.1374 to $0.08 by persistent effort, but when the efforts were relaxed expenses immediately rose to $0.17. They should have come down to $0.06. Eastern and Southern roads, with their small engines, better coals, and better waters, are not to imagine that they show any higher efficiency. They are on the whole worse.—*Harrington Emerson in The Engineering Magazine.*

EXPERIENCE AS A TEACHER.—A great deal used to be said about learning from experience, because then there was no other source of learning, text books were very few and of a very poor quality, as their grammatical construction was more carefully looked after than their mechanical accuracy. Nowadays text books and instruction books are so numerous as to almost crowd up against you. Experience as the only teacher is only a poor excuse today. A railroad man cannot live long enough to experience all the breakdowns that can happen to a locomotive. The man who raises the loudest hurrah for experience as the only teacher generally suffers most from his method in his early schooling, for his "experience consists in having an engine break down and tie up the road for a time and then after the investigation serving from ten to thirty days for a lack of knowing how."—*C. B. Conger before the Traveling Engineers' Association.*

The number of miles of railroad per one hundred square miles of territory for the United States, June 30, 1906, was 7.55 as against 7.34 for the previous year.

# THE DYNAMICS OF LOCOMOTIVE MACHINERY

By "G. E."

The object of this investigation was to apply to the locomotive certain mathematical processes employed in other engineering work, to see if they would bring out any new, valuable, or interesting facts. It is believed that the results are of interest, and that they throw some light on the behavior of certain locomotive details.

The locomotive described below will be considered in this investigation:

| | |
|---|---|
| Type | Pacific |
| Cylinders | 21 in. × 26 in. |
| Driving wheels | 73 in. diameter |
| Boiler pressure | 200 lbs. per sq. in. |
| Transverse spacing of cylinder centers | 88 in. |
| Transverse spacing of frame centers | 44 in. |
| Transverse spacing of counterbalance centers | 63 in. |
| Transverse spacing of parallel rod centers | 77 in. |
| Length of main connecting rod | 128 in. |

When the engine is exerting the maximum drawbar pull at slow speed, it will show an indicator card similar to that in Fig. 1. At any point of the stroke the effective force that moves the piston is equal to the difference between the pressures on the two sides; that is, the difference between the pressure of the admission, or the expansion line of the diagram, for one end of the cylinder and the back-pressure of the exhaust, or the compression line, of the other diagram at the corresponding points. If, then, the upper part of one diagram is combined with the lower part of the other, with due allowance for the area of the piston-rod section, the resulting figure shows the effective pressure for one stroke. Fig. 2 shows such a diagram, which we will call a stroke card, worked out from the indicator card in Fig. 1.

Following the action of the force resulting from this effective pressure we find that it is transmitted directly to the crosshead wrist-pin, where it is resolved into two components, one acting along the main rod and the other constituting a vertical pressure on the guides. This latter is at its maximum—about 7,000 lbs.—when the crank is on the quarter. Its recurrence alternately on the two sides of the engine causes the very noticeable rocking of the machine when working hard at slow speed.

Following the other component back to the vertical center line of the main driving-wheels, it resolves into vertical and horizontal components. The vertical one is just equal to the crosshead pressure on the guides, and represents an increase in "weight" at the main drivers in going forward and a decrease in backing. *This is one of the reasons why most types of engines are less likely to slip their drivers in going forward than in backing.*

Fig. 3 shows a method of determining the pressures of the driving-boxes against the shoes and wedges. In this case the three boxes on each side of the engine are treated as one, and so the pressures found are the sums for the three boxes. A B and C D are the driving wheels, E and F are the centers of the journals, K is the middle point of A C, G and L are the points where the center lines of the main connecting rods, extended if necessary, intersect the vertical, transverse plane of the center line of the axle. Moments are taken about the line E K, the forces being the horizontal components of the crank-pin pressures above referred to, and there is found the pressure at F required to balance those at the crank-pins.

These pressures are plotted in Fig. 4, as are also the sum of the net cylinder-head pressures for the two sides of the engine. The algebraic sum of these is the force that is transmitted through the frames to the foot plate, and (neglecting friction and wind resistance) becomes the tractive force of the engine, which, also, is plotted in Fig. 4. It has the familiar form of the tractive-force curve, and *explains why the driving wheels are most likely to slip when the crank angle is about 45 or 135 degrees.* The straight, horizontal line drawn at the average height of the tractive-force line is the average tractive force, or the tractive-force that is obtained by application of the usual formula to the mean effective pressure of the indicator card.

The tractive force is shown to be but a small balance of the enormous forces that act through the frame. For example, in this case, with a tractive force of but little over 30,000 lbs., the driving-box pressures produce a compression of 153,000 lbs. in the left-hand frame, between the cylinder and the front driver. *When it is remembered that this is an alternating stress and that a slight eccentricity of its resultant can produce a maximum intensity of stress as great as five or six times the average, the severity of the service on some frames is apparent. It is evident, too, that the stresses in electric-locomotive frames are entirely different, and their design should not be based on steam locomotive practice.*

If there is any pound in the boxes, it takes place where the curves of driving-box pressure cross the line of zero pressure. At the point of crossing on the right-hand side the pressure increases instantly to a greater pressure than is similarly reached on the left-hand side. *This provides an explanation for the more frequent breakage of frames on the right side than on the left, which is believed to be the common observation.* Of course, if the left crank leads, the opposite condition will result.

At high speeds the inertia of the revolving and reciprocating parts has to be considered. Fig. 5 shows a graphical method of doing this, which is derived from a combination of methods given by Professor Klein and by Mr. Wilfred Lewis. The full lines are the essential ones, and the dotted lines apply only to the proof, which is given in the appendix. O is the center of the driving wheel, O C the crank, C W the connecting rod, and H the center of percussion of the connecting rod. O A is perpendicular to the line of centers OW, and the arc to $tCp$ is drawn on CW as a diameter. Arc $tAp$ is drawn through A, about the center C. Lines $t\ p$ S and CS are drawn through points already located. HI is drawn parallel to OW, and IK, CN, and LM are perpendicular to OW. RN is made equal to OR, and WN is drawn. $WA^1$, perpendicular to OW, is made equal to OA and $CA^1$ is drawn. Let $r$ represent the length of the crank and $v$ its angular velocity. Then

$(OA) \times v =$ velocity of W.

$(GL) \times v =$ component of the velocity of H in the direction of the line of dead points.

$(GM) \times v =$ component of the velocity of H in the direction perpendicular to the line of dead points.

$(OC) \times v^2 =$ acceleration of the crank-pin in magnitude and direction.

$(OS) \times v^2 =$ acceleration of W.

$(OI) \times v^2 =$ acceleration of H, and $(IK) \times v^2$ and $(OK) \times v^2$ its components parallel and perpendicular respectively to the line of dead points.

Consider the engine running at 60.5 miles per hour and giving the indicator card shown in Fig. 6. The corresponding stroke cards are given in Figs. 7 and 8.

The main rod, when swung as a pendulum on a knife-edge passing through the center of the forward bearing, makes 36 single oscillations per minute. The length of the equivalent simple pendulum, or the distance from the center of the forward bearing to the center of percussion, is, therefore, 108½ inches. Divide the weight of the rod into two parts, one concentrated at the center of percussion and the other at the center of the forward bearing, and so proportion those parts that the location of the center of gravity of the rod will not be altered. Then the moment of inertia of the rod will not be altered, and the effects of the inertia of the rod on all other parts will remain unchanged. The weight at the center of percussion will be the total weight of the rod multiplied by the ratio of the distance of the center of gravity from the front bearing to that of the center of percussion from the same point. The remaining weight

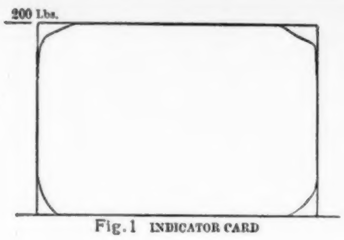



Fig. 1 INDICATOR CARD

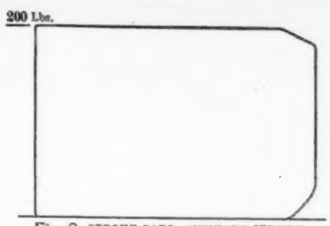



Fig. 2 STROKE CARD, OUTWARD STROKE

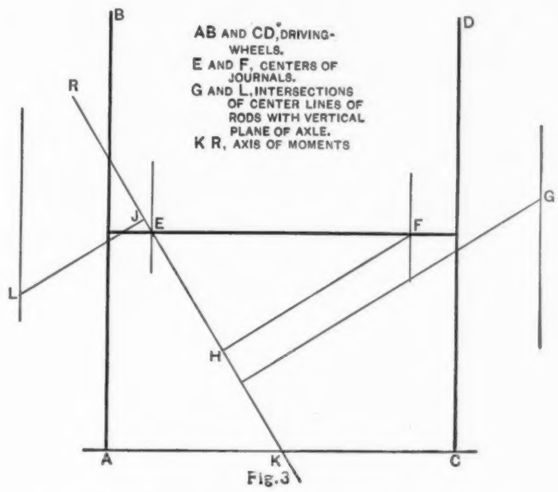



FIG. 3.—DRIVING-WHEEL MOMENT DIAGRAM, SHOWING METHOD OF DETERMINING PRESSURES OF DRIVING BOXES AGAINST SHOES AND WEDGES.

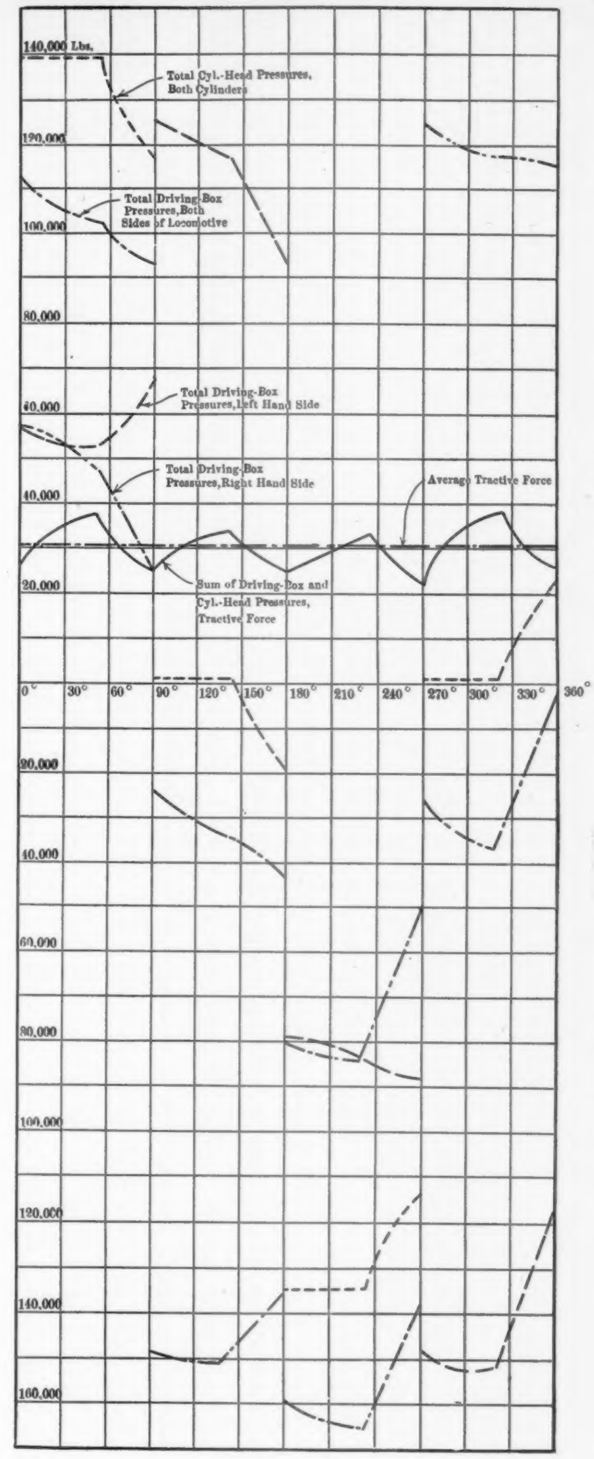



FIG. 4.

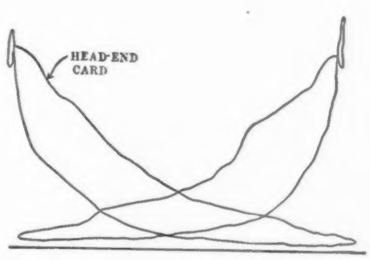



FIG. 6.—INDICATOR CARD TAKEN WHILE LOCOMOTIVE WAS RUNNING AT A SPEED OF 60.5 MILES PER HOUR.

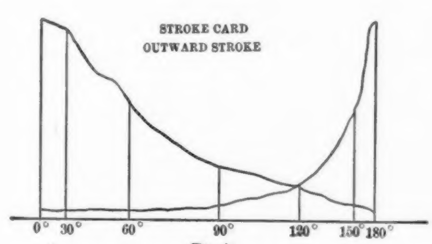



Fig. 7

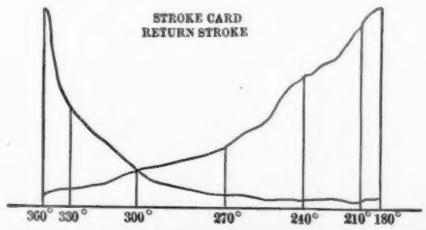



FIG. 8.

FIGS. 7 AND 8.—STROKE CARDS FOR THE INDICATOR CARD SHOWN IN FIG. 6.

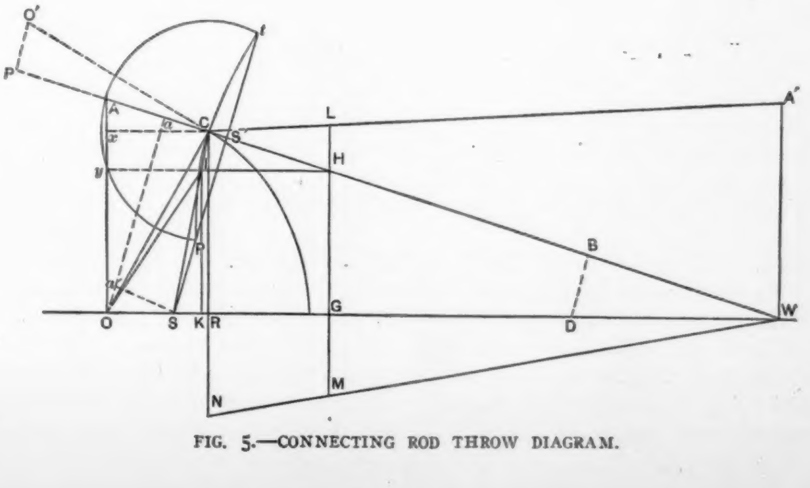



FIG. 5.—CONNECTING ROD THROW DIAGRAM.

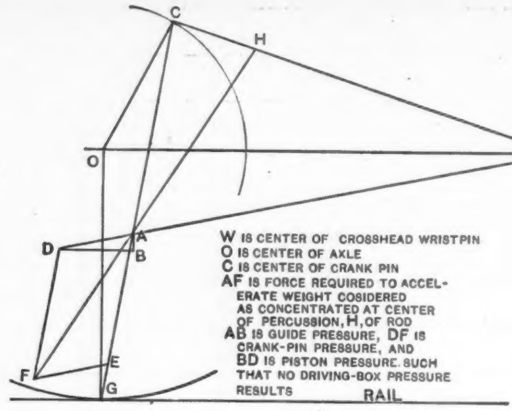
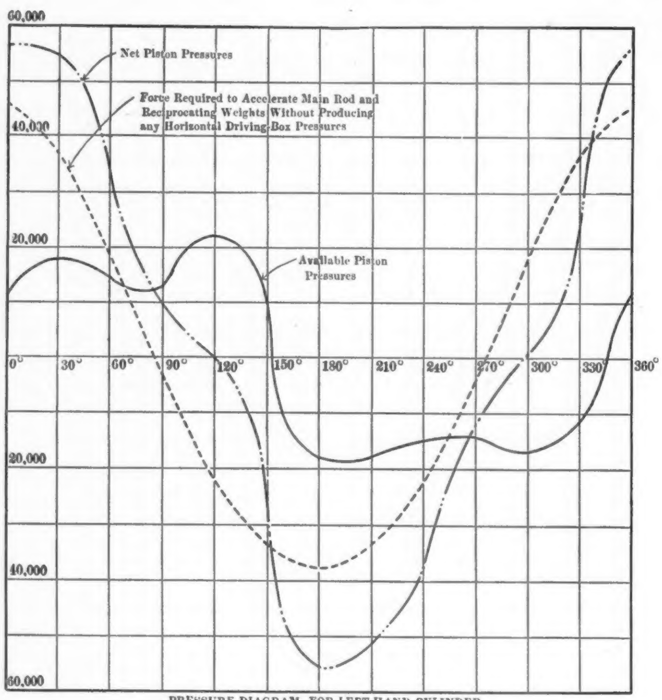
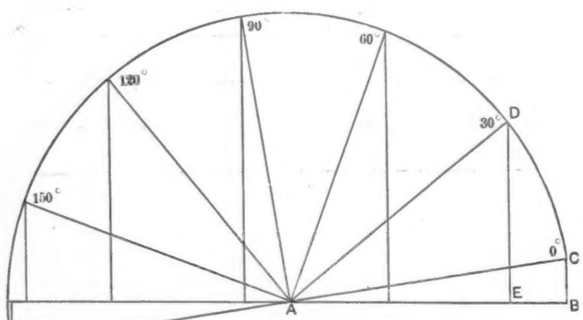



FIG. 9.



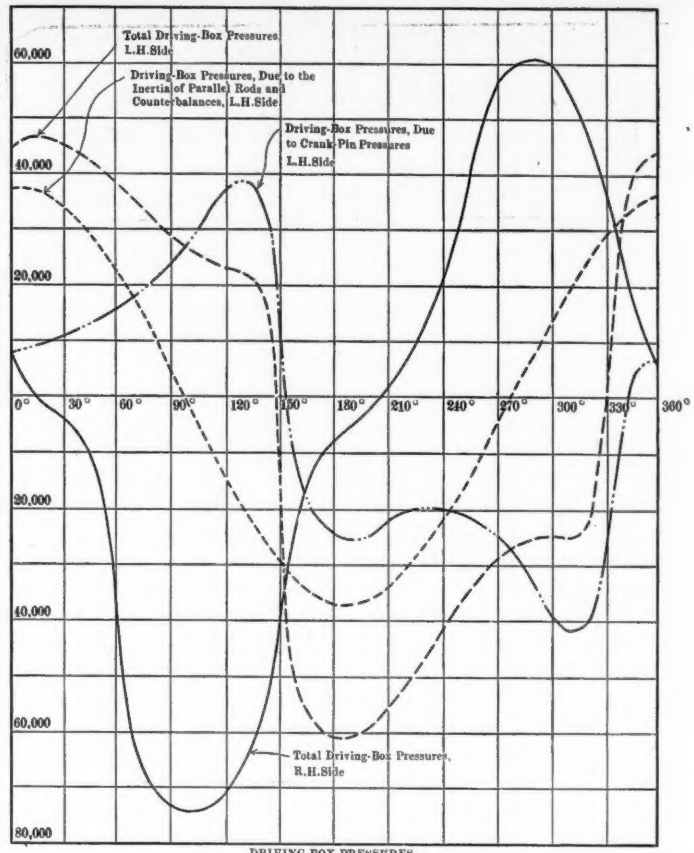

PRESSURE DIAGRAM, FOR LEFT HAND CYLINDER

FIG. 10.



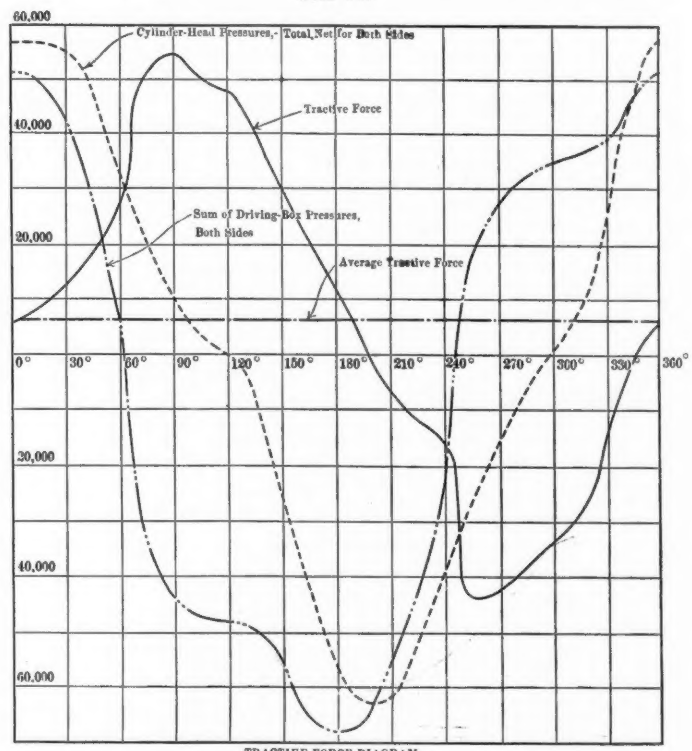

VECTOR DIAGRAM OF REVOLVING WEIGHTS

FIG. 13.




DRIVING-BOX PRESSURES

FIG. 11.




TRACTIVE FORCE DIAGRAM

FIG. 12.

is considered as concentrated at the front bearing, so that it, the piston, piston-rod, and crosshead constitute the reciprocating weights, the sum of which, when multiplied by $(OS) \times \frac{v^2}{g}$ (Fig. 5) gives the force required for their acceleration.

To ascertain the forces required to accelerate the weight at the center of percussion, the diagram in Fig. 9 is made, the points O, C, H, and W being the same as in Fig. 5. OG is the radius of the main wheel, and G is its point of contact with the rail. In order that the action of the rod shall not produce pressure of the driving-boxes against the shoes or wedges, the direction of the force exerted by the crank-pin on its bearing must be in the direction CG. The direction of the resultant force acting on the mass at H must be HA, parallel to OI in Fig. 5. Therefore, the force at the crosshead-pin must act in the direction WA; if AF represents the mass at H multiplied by its acceleration, (OI) $\times v^2$ (Fig. 5), AD will be the corresponding force at the crosshead, BD being supplied by piston pressure and AB by guide pressure.

In Fig. 10 are plotted the net piston pressures in the left-hand cylinder and the forces required at the piston to accelerate the reciprocating weight as well as the weight at H, found as above described. There is also shown the difference between these two,

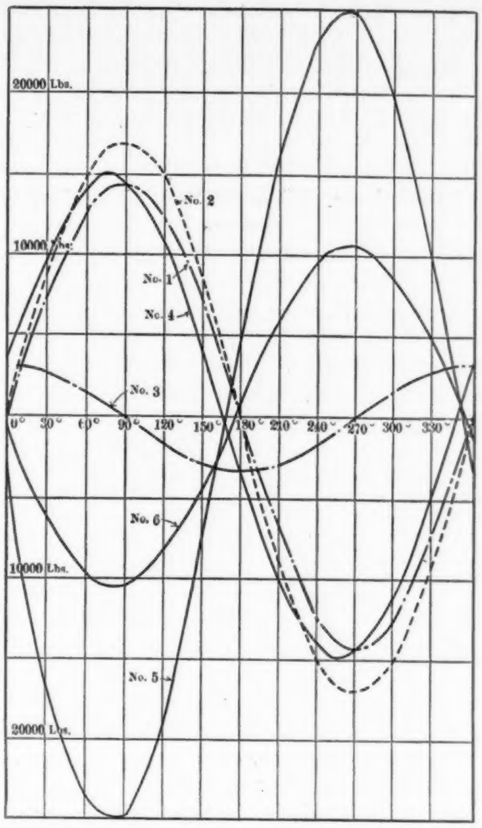



FIG. 14.—VARIATION IN VERTICAL RAIL PRESSURE, MAIN DRIVING WHEEL, LEFT SIDE OF ENGINE.

Curve No. 1. Due to reciprocating weights and main rod, left side.
Curve No. 2. Due to weight at crank pin equal to weight of back end of main rod.
Curve No. 3. Due to reciprocating weights and main rod, right side.
Curve No. 4. Sum of Nos. 1 and 3.
Curve No. 5. Due to parallel rods and counterbalances.
Curve No. 6. Sum of Nos. 4 and 5.

which is the force available for transmission to the crank-pin for producing driving-box pressure. The force required for the acceleration of the weights is shown to constitute a considerable portion of the net piston pressure.

In Fig. 11 is plotted the driving-box pressure due to the available net piston pressure, obtained as in the case of the slow-speed diagram. There is also plotted the driving-box pressure due to the parallel rods and counterbalances. These may be found by multiplying the centrifugal forces by the cosine of the crank angle and by the leverage due to the frame spacing, and adding the various products. This, of course, can be done by computation or graphically. The same results can be obtained by means of the vector diagram shown in Fig. 13, which method is similar to that by which sine waves of alternating voltage or current strength are combined by the electrical engineer. AB is the centrifugal force at the side near the box, multiplied by its leverage, while BC is the centrifugal force on the opposite side multiplied by its leverage. AC is the resultant force, and AE and DE are its components when it has revolved through some angle, as 30°. There are also plotted in Fig. 11 the total driving-box pressures for each side.

In Fig. 12 are plotted the total cylinder-head pressures and the total driving-box pressures for both sides. The difference between these is the tractive force, the average of which agrees with that obtained by formula, using the mean effective pressure of the indicator card. *It should be noted that the average tractive force is very small compared with either the maximum or minimum tractive force or the total loads on the frames; that during a part of the revolution of the wheels there is a considerable negative tractive force, tending to retard the speed of the train; that the variation in tractive force is much greater than at slow speeds, producing the familiar fore-and-aft vibrations so noticeable on engines at high speed; but that the forces acting on the frames are much smaller at high speed than at low speed.*

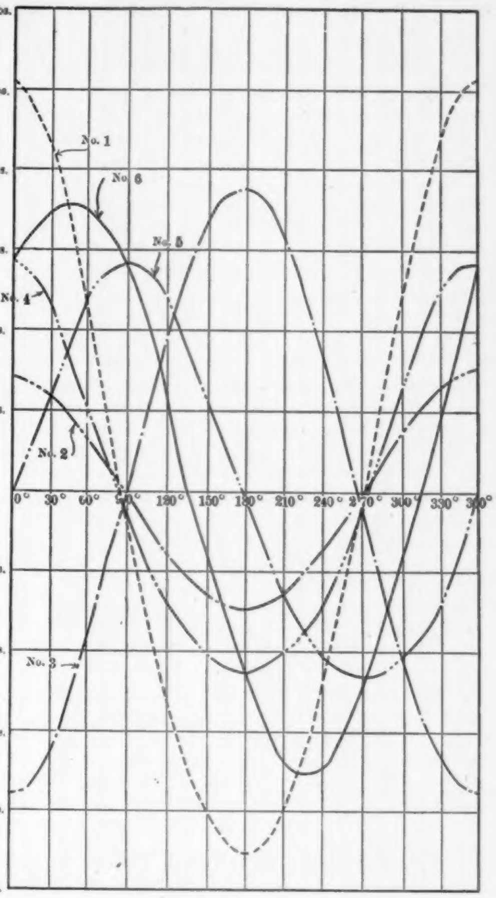



FIG. 15.—DIAGRAM OF TURNING MOMENTS DUE TO INERTIA OF REVOLVING AND RECIPROCATING PARTS AT A SPEED OF 60.5 MILES PER HOUR, BEGINNING AT FORWARD DEAD POINT, LEFT-HAND SIDE. POSITIVE MOVEMENTS TEND TO FORCE FRONT END OF THE ENGINE TO RIGHT.

| Curve No. | Moment Due To: |
|---|---|
| 1 | Main rod and reciprocating weights, left side. |
| 2 | Parallel rods, left side. |
| 3 | Counterbalances, left side. |
| 4 | Sum of Nos. 1, 2 and 3, left side. |
| 5 | Corresponding to No. 4, right side. |
| 6 | Sum of Nos. 4 and 4. |

If we wish to get the variation in vertical rail pressure, we return to Fig. 5, where $(IK) \times v^2 \times \frac{WH}{WC}$ multiplied by the leverage of the transverse wheel spacing and the overhang of the crank-pin, and by the mass concentrated at H, will give the load at the rail due to the throw of the main rod. If the engine is working steam, the available piston pressure will produce a crank-pin pressure which will have a vertical component to be added to the vertical throw of the main rod already obtained; if the engine is drifting, the inertia of the reciprocating parts will produce a crank-pin pressure to be similarly treated. Fig. 14 shows the variation in vertical rail pressure at the left-hand main wheel. It is often assumed that the weight required for perfect vertical balance is one to balance the static weight of the back end of the main rod. Curve No. 2 shows the variation in rail pressure due to such a counterbalance. It differs markedly from curve No. 1, which shows the actual variation, and the difference would be still more pronounced if the rod was shorter. The methods of obtaining the other curves of this figure are apparent from what has preceded. Curve No. 6 shows the vertical overbalance.

Fig. 15, derived in a similar way, shows the tendency of the engine to oscillate about a vertical axis. This is a diagram of moments, however, and the arms of the moments are the distances of the moving parts from the center of the engine. This diagram brings out the well-known fact that, though the engine is overbalanced vertically, it is underbalanced horizontally.

Modifications and a number of other applications of the diagrams will suggest themselves to those who desire to use

them. Following is the proof of the facts stated about Fig. 5 on page 378.

APPENDIX.

If we denote by $v$ the angular velocity of the crank, (OC) $\times v$ will represent in magnitude the linear velocity of C, and (OR) $\times v$ and (CR) $\times v$ will be its vertical and horizontal components respectively. Draw $CO^1$ perpendicular to OC and equal to it in length. $(CO^1) \times v$ will represent the component of it acting along WC. WB is next made equal to CP, and BD is drawn perpendicular to WC. Then (WD) $\times v$ represents the velocity of W in magnitude and direction. From the similarity of triangles O$a$C and $O^1PC$, and AO$a$ and BDW, it follows that OA = WD, and that (OA) $\times v$ represents the velocity of W in magnitude.

Since (CR) $\times v$ and (RN) $\times v$ represent the horizontal and vertical components of the velocity of C, and since (WD) $\times v$, $= (WA^1) \times v$, represents the horizontal velocity of W, the proportionality requires that (GM) $\times v$ and (GL) $\times v$ represent in magnitude the vertical and horizontal components respectively of any point H in the rod.

(OC) $\times v^2$ represents the acceleration of the crank pin, and (C$a$) $\times v^2$ is its component along WC. Since (OA) $\times v$ is the velocity of W and (OC) $\times v$ that of C, both perpendicular to the actual directions of motion of these points, (AC) $\times v$ will be the velocity of C relatively to W. Therefore $\frac{(CA)^2 \times v^2}{(CW)}$ is the acceleration of C relatively to W, due to the oscillation of the rod about W. Now $CS^1 = \frac{(Cp)^2}{CW} = \frac{(CA)^2}{CW}$, therefore $(CS^1) \times v^2$ is the acceleration of C relatively to W. The total component of the accelerationn of W, in the direction WC is, therefore, $(Ca) \times v^2 + (CS^1) \times v^2 = (S^1a) \times v^2 = (Sa^1) \times v^2$. The actual acceleration of W in its actual direction is (OS) $\times v^2$. Since (OC) $\times v^2$, having components (OR) $\times v^2$ and (CR) $\times v^2$, represents the acceleration of C, and since (OS) $\times v^2$ similarly represents that of W, it follows from the proportionality that (OI) $\times v^2$ is the acceleration of any point in the rod as H, and (OK) $\times v^2$ and (IK) $\times v^2$ are its horizontal and vertical components respectively.

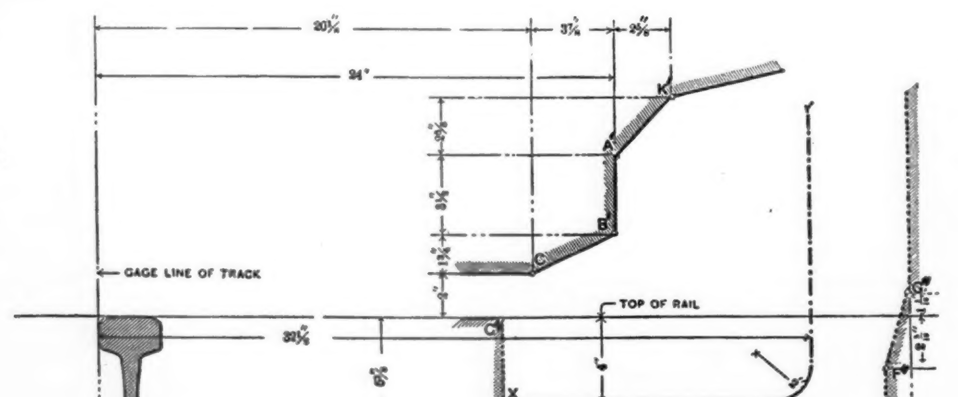
## STANDARD LOCATION OF THIRD-RAILS.

At the last meeting of the American Railway Association the following resolutions were adopted:

"1. That the diagram showing lines of clearance be approved and made the standard of the American Railway Association; and that in the future construction of rolling stock and roadways these clearance lines be carefully adhered to by the members of the association.

"2. That in designs of new rolling equipment which is to be used in interchange, the clearance line K′, A′, B′, C′, including such horizontal and vertical variations which may in any reasonable probability occur in combination at one time, should not be exceeded. In determining this, the position of the equipment on a 20-degree curve should be considered, making allowance for the side throw of the bolster and the consequent effect on the location of such portions of the equipment that are attached to the car body. Variations in equipment should be allowed for as follows: Horizontal, 2½ inches in all; vertical, 4 inches in all.

"3. That in design of new bridges, trestles, tunnels and platforms, no part that is continuous for more than seven feet should come within the space indicated for third-rail structures, that is, A, B, C, D, E, F, G, H, I, J, K, and should preferably clear this line by at least one inch, as is shown by the line C″, D″, E″, F″, G″, but that structures which are not continuous for more than seven feet may be allowed to come to the line X Y."




CLEARANCE DIAGRAM FOR THIRD RAIL.

## LONGITUDINAL vs. TRANSVERSE ERECTING SHOPS.

In speaking before the Canadian Railway Club, H. H. Vaughan had this to say of the transverse shop:

"I was quite a believer in the transverse shop when I went to the Lake Shore & Michigan Southern, but I am now prepared to endorse the longitudinal shop. The first objection I have to the double banked transverse shop is the inflexibility of it. Everything has to come in or out on either one or two tracks. I cannot help but feel that a recognition of the inflexibility of the double banked shop is shown by the plans in which a transfer table is used with a transverse shop.

"The transverse shop is a great deal misunderstood as regards floor space required. For instance, we will say that you have a pit section 60 feet wide. The fact is overlooked that in the machine shop there is a through track, as a rule about 15 ft. from the erecting shop, and the whole of the space between the repair shop and the track is taken up with wheels and storage, so that the transverse shop is generally about 80 feet instead of, as a rule about 65 feet, in the longitudinal shop; this takes a lot of space off the machine shop. I think if the longitudinal shop is laid out with the same floor space as the transverse shop that there is no appreciable difference in handling either engines or material, but I consider that in a longitudinal shop, transverse aisles leading to the machine shop should be arranged for about four or five engines apart. We did try to work that at Angus to a certain extent, but we were blocked by the arrangement of the machines, which had already been located in many cases. Had we been able to carry it out we would have had a most convenient shop for transferring material.

"There is another point and that is the effect of the type of shop on the lay-out of the machinery. All transverse shops have the same defect, the heavy tools are located along the track through the machine shop and block the movement to the back of the shop and the lighter machines, and the bench work has to be located under the gallery. In the longitudinal shop you can locate all the heavy tools close to the repair shop, leaving the space on the opposite side of the through track for the lighter tools, so that material can be handled to the heavy tools on one side and to the lighter tools on the other side of the machine shop track, and it is possible, as has been arranged at Angus, to place all the bench work out under the crane service keeping the lighter tools on which the work can generally be more easily watched under the gallery.

"It is stated that in a transverse shop it is easier to handle wheels, as a rule, than in a longitudinal shop. This is not true, however, of flues, boilers, and a variety of material, all of which can be handled through a longitudinal shop, and not have to be handled through the machine shop first. I feel there is a difficulty to make out any case for the superiority of the transverse shop, and if so, there is no reason for the additional expense it entails."

The directors of the Illinois Central Railroad, at a meeting in New York, September 16, authorized the appointment of a commission to fully investigate the matter of electrifying the Chicago terminal.

# SECOND ANNUAL CONFERENCE OF THE APPRENTICE INSTRUCTORS, NEW YORK CENTRAL LINES.

The second annual conference* of the apprentice instructors of the New York Central Lines took place at Depew, N. Y., September 3. In addition to C. W. Cross, superintendent of apprentices, Henry Gardner, his assistant, and the instructors whose names are shown on the accompanying table, the following guests were present: C. H. Hogan, division superintendent of motive power; F. M. Gilbert, mechanical engineer; F. W. Thomas, supervisor of apprentices, Santa Fé., and Henry Maxwell, educational instructor of apprentices in the locomotive department of the Canadian Pacific Railway Company at Angus Works. At the opening of the conference letters were read from J. F. Deems, L. H. Turner and G. M. Basford. Following are extracts from these:

| Drawing Instructor. | Shop Instructor | Shop. |
|---|---|---|
| A. W. Martin | W. J. Greilich | Beech Grove, Ind. |
| R. M. Brown | H. J. Cooley | Collinwood, O. |
| G. Kuch, Sr. | G. Kuch, Jr. | Depew, N. Y. |
| F. Deyot, Jr. | L. T. Johnson | East Buffalo, N. Y. |
| C. A. Towsley | M. T. Nichols | Elkhart, Ind. |
| C. P. Wilkinson | C. T. Phelan | Jackson, Mich. |
| V. J. Burry | J. R. Radcliffe | McKees Rocks, Pa. |
| H. S. Rauch | F. Hanley | Oswego, N. Y. |
| H. R. Martinson | H. R. Martinson | St. Thomas, Ont. |
| A. L. Devine | F. Nelson | West Albany, N. Y. |

*Mr. Deems.*—"There is no more important problem now confronting the railroads, and especially the mechanical department of railroads, than the future relationship between the employees and the companies. You are engaged in the work of the systematic training of apprentices in the theory and the practice of the trades, to raise the standard of mechanics in the shops, for the mutual benefit of the company and the employees.

"The value of this plan of training apprentices may not be apparent in the first year of apprenticeship, but later it is shown there is a very decided benefit to the apprentice himself, as well as the company, and in time this must be reflected in the community.

"Those of us who have served an apprenticeship under the old régime know the difficulties we had to overcome in learning the trade. It is believed the apprentices on our lines fully appreciate the privileges afforded, as is evidenced by the eagerness and ambition displayed on their part, which is commendable to both the instructors and the apprentices.

"The relation of both the drawing instructor and the shop instructor to the local organization is especially important, he should make every effort to impress on all concerned that his efforts are co-operative with the object of increasing the output and efficiency of the shop in general."

*Mr. Turner.*—"I cannot refrain from saying to you that I am very much impressed with the work that is being accomplished, which is sure to result in building up a much better class of mechanics on the Lines; also a better class of men to draw from when men are to be selected to take supervisory positions. You are to be complimented on the splendid work you are doing."

*Mr. Basford.*—"It would be a great pleasure to me to meet the men who are working out the details of a plan which seems to be one of the most important movements of the time in the most important problem of the time—transportation.

"For many years I have dreamed of seeing apprenticeship worked out practically on a large scale, as you are working it out, and that the dream has come true is almost too good to believe.

"What does it matter if the work involves a good deal of drudgery? Is there any work worth while which does not involve it? I think that everything should be said and done to encourage those who are carrying the burden of this effort. The most encouraging thing that I can think of to say is that there is nothing in any industrial or transportation organization which begins to approach in importance and in the possibilities of far-reaching results, this preparation of recruits who are to be the men of the future. I think you should bear in mind the fact that the New York Central Lines were first in the field in a broad effort of this sort. Remember that other railroads are watching and following you and that it will be necessary to be alert and active in order to maintain the lead which you now hold. The best of success to you and to all who are helping you in this development which has been so ably organized by Mr. Deems."

*C. H. Hogan, Div. Supt. M. P.,* then spoke in part as follows: "We see here at Depew Shops the results of the labor of the apprenticeship department. The company has incurred the expense of installing the school and providing for the practical training of apprentices—to educate them to become skilled mechanics. At first the apprentice may not think much of the training he is being given, but at the end of the fourth year he will say that he would not have gained the theoretical knowledge and thorough practical training if it were not for your efforts, and he will show his gratitude for the opportunity given him. The other day a professor from one of the high schools of Buffalo visited our school and shop and expressed his surprise that the railroad company took so much interest in their apprentices and stated he would like to have all his instructors visit our school."

*Mr. Cross' Address.*—Mr. Cross then addressed the conference. He directed attention to the rapid extension and progress of modern apprenticeship methods on railroads throughout the country and reviewed the work of the apprenticeship committee at the last meeting of the Master Mechanics' Association. He closed with the following remarks:

"The testimony of all subordinate officers and others who are in a position to know, is to the effect that the company is deriving benefits from the training of apprentices and that the apprentice work is on a conservative and substantial basis. The shop instructor increases the efficiency and consequently the output of the apprentices by his instructions, and the drawing instructors increase their knowledge and efficiency by the instruction given in drawing and mathematics.

"The New York Central Lines plan of apprenticeship is intended to provide for recruiting the service by combining the shop instruction with the theoretical training. We feel that the work has now passed the experimental stage and has become a regular part of the work of the railroad. The value of this plan of training is that it enables the company to reap an immediate, as well as an ultimate benefit from the work done by apprentices, due to the special training they receive both in the school room and the shop. The aim is to have a light crop over a large area, rather than a phenomenal growth of a few plants. The progress made during the year indicates a substantial growth of the ideas of apprenticeship for recruiting the service. The apprentices everywhere acknowledge by their earnestness their gratitude for the opportunity offered for self-improvement. The interest displayed by the apprentices so far is very gratifying, and is increasing in proportion as the facilities for experimental work are increased and the plan of instruction is extended."

*An abstract of the proceedings of the first annual conference will be found in the November, 1907, issue of this journal.

**Apparent Benefits From Improved Apprenticeship Methods.**

BY HENRY GARDNER.

GENERAL BENEFITS TO SHOPS.

Investigation shows that the apprentices in all departments are doing better work than formerly—are in fact doing certain classes of high-grade work, which under the old system it was not thought wise to entrust to them.

Discipline in the shop is better. Foremen are relieved of the care of the boys and can give more attention to their other duties. The shop instructor takes charge of the apprentices and contributes materially to increasing the output by his constant teaching and inspection. The best grade of work is given boys in all departments. It is a common occurrence in all shops to excuse a boy from the class room in order to run a machine left idle by an absent workman, thus keeping up the output of the machine.

The tone of the shop is improved in several cases by high school boys as apprentices. This is the natural result of the educational advantages offered by modern apprenticeship. There is a steady gain in the boys' ability to read blue prints and drawings. This faculty is strongly marked during the third and fourth years. Boys can read ordinary shop prints at the end of the first year.

Debating clubs give the boys an opportunity to write and talk on mechanical subjects. Speaking in public makes and develops initiative. The ability to do this is traceable to the class-room instruction. Club socials and picnics bind boys to their fellow-workmen and build up valuable friendships. The boys learn to understand and respect their superiors, but not to fear them. The baseball club, if properly managed, may be classed as a benefit. Boys are broadened by their visits to other shops. The unity of the club teaches that success is due to team work.

GENERAL BENEFITS TO THE DRAFTING ROOM.

Boys are used in the drafting room both before and after graduation. Before graduation those best fitted for the work spend three months making blue prints, drawings and tracings. After graduation, boys especially adapted are used to advantage as regular draftsmen. When rushed the head draftsman takes drawings to the apprentice class room to be worked up or traced. Apprentices assist the drafting room in making numerous tests, such as indicating engines, dynamometer car tests, coal tests, etc.

During the past year a total of 1,344 drawings and tracings have been made for the company's drawing room files by apprentices. Part of these were made in the class room and others by apprentices especially detailed for drawing room duty.

SPECIAL INSTANCES OF GOOD WORK IN THE SHOP.

*(These are a few of many jobs which indicate the class of work which is open to the apprentices, as well as the fact that they are taking advantage of their opportunities.)*

*West Albany Shops.*—A first year apprentice, with only two weeks experience, bored twelve eccentrics in thirteen hours, and five eccentric straps in seven and a half hours.

A second year apprentice, with helper, set the valves on an engine in seven hours. Set valves on two other engines in good time.

A second year apprentice, with helper, lined up two sets of guides and coupled up pistons, all in six hours. Boy had three months' experience in this work.

A third year apprentice in charge of the rod job, repaired thirty-two main rods, ten pairs front end brasses, and eighteen pairs back end brasses. He also made two sets of front end brasses. All of this work was done in three weeks.

MEMBERS PRESENT AT APPRENTICE INSTRUCTORS' CONFERENCE.

Top row, reading from left: G. Kuch, Sr., H. J. Cooley, F. Hanley, H. S. Rauch, A. W. Martin, M. T. Nichols, and H. Maxwell (Can. Pac. Ry.). Middle row, reading from left: G. Kuch, Jr., F. Nelson, L. T. Johnson, F. W. Thomas (Santa Fe), C. W. Cross, Henry Gardner, C. P. Wilkinson, C. A. Towsley, and H. R. Martinson. Bottom row, reading from left: R. M. Brown, W. J. Greilich, F. Deyot, Jr., C. T. Phelan, A. L. Devine, V. J. Burry and J. R. Radcliffe.

*Collinwood Shops.*—A first year apprentice applied two boiler checks to a new boiler, laid out and tapped holes for studs and ground the seats, completing the job in twelve hours.

Apprentice boys ran a 42 in. truck wheel lathe, turning an average of five pairs of tires per day. The average done by the regular piece worker on this job was six pairs per day.

The third year foundry apprentices are doing regular moulding work at the bench.

A third year boy patched a cylinder, assisted by a helper.

A third year apprentice and helper took charge of the truck job temporarily. Work was satisfactory.

*Elkhart Shops.*—A third year apprentice laid out a drop pit jack for engine house from blue print.

*Oswego Shops.*—Apprentice with three months' experience, with helper, ran the link job successfully. The regular man was temporarily absent.

A statement of eleven boys working piece work shows an average increase in rate of pay for June over May, 1908, of 15 per cent. This increase is mainly due to the appointment of a shop instructor.

*McKees Rocks Shops.*—Two fourth year apprentices had full charge of a pit with an engine in for general repairs. The boys ordered all parts, made sketches for new bolts, lined up the guides, laid off the shoes and wedges, wheeled and trammed the engine and set the valves. The foreman advised them as is customary in ordinary cases.

A fourth year apprentice took complete charge of erecting a new engine, including the following jobs: leveling and squaring the frames, scribing and chipping the saddle, laying off the shoes and wedges and wheeling and tramming the engine. He did not set the valves. The foreman advised, as customary.

Specific Benefits to the Drafting Room.

*West Albany.*—A graduate machinist apprentice went to the New York office as a draftsman. Prior to that time he attended shop evening classes for two months, and public school evening classes for six months, winning a medal for the best drawing in the public school evening classes.

A fourth year apprentice redesigned a grease molding machine, including one assembly and ten detail drawings. He also designed a set of dies for bending fire rake handles. These dies are now in use.

Eight boys, machinist apprentices, have assisted on dynamometer car tests.

*Collinwood.*—A first year machinist apprentice is drawing forging machine dies for office record.

A second year machinist apprentice made a complete list of all regular tools in the shop, collecting prices and putting a value on each.

Two second year machinist apprentices were on a coal test for four months, checking and weighing amount of coal used for locomotives.

A third year machinist apprentice conducted a test of a Haushalter speed recorder, riding on passenger engines between Chicago and Buffalo.

A third year machinist apprentice is making a complete set of drawings of boiler hand tools for office use.

*Elkhart.*—Three machinist apprentices, fourth, second and first year, are running a coal test.

A fourth year machinist apprentice spent six months as a draftsman in the Cleveland office.

*Oswego.*—A third year machinist apprentice made the drawings for a bolt shear, while in the drawing room. He worked up the details from notes and sketches. The shear was made from these drawings.

*McKees Rocks.*—Two fourth and one second year apprentices have for the past six months been sketching and drawing bulldozer dies for the mechanical engineer's office. This work was done during school hours.

A third year machinist apprentice, with the instructor's assistance, has designed a complete link and reversing gear for the small stationary engine in the class room. All parts will be made in the shop from these drawings.

A graduate apprentice has been enrolled as a regular draftsman in the mechanical engineer's office.

Two apprentices will be chosen to assist the drawing room force in making some dynamometer car tests.

## Apprentice Clubs and Baseball Teams.

Reports of Progress.

*Depew (G. Kuch, Sr.)*—An apprentice debating club was organized last December. Discussions are carried on during the noon hour. The apprentices are divided into three classes, machinist, boiler maker and blacksmith, each taking up subjects in their own line, but open to all for debate. The assistant shop draftsman is chairman of the club, the assistant chairman and recording secretary being apprentices. The meetings were a complete success and were largely attended not only by the apprentices but by the shop foremen and journeymen. From the organization of the club the foremen have been regular attendants and have willingly instructed the apprentices whenever called upon. They also wish to be informed of the names of the apprentices who miss these meetings.

Following is a list of the subjects which were discussed. How does water enter the boiler with the same amount of pressure on the boiler check as on the injector? What are the advantages and disadvantages of the Stephenson and Walschaert valve gear? Functions of a slide valve and a piston valve. Different kinds of welds. Method of keeping fires in a forge to obtain the best results. Why are 2-in. flues used in a locomotive boiler instead of 3 or 3½ in.? Different types of locomotive boilers. How many different kinds of seams are there in a locomotive boiler? How to find the pressure on a staybolt.

The club adjourned April 15th because of warm weather and in order to organize a baseball team. Funds for securing uniforms and a complete baseball equipment were obtained from the proceeds of a ball which was conducted entirely by apprentices. The baseball team, composed of apprentices, has played six games.

*Elkhart. (C. A. Towsley).*—The apprentice club at this point is under the necessity of renting a room; because of this the dues are higher and the membership has fallen off somewhat. It is expected, however, that with longer working hours and more pay it will be considerably increased. The proceeds of an ice cream social has helped the club to better its financial condition.

A number of talks have been given by various shop foremen, including the following subjects: Drilling and drilling machines. Stephenson valve motion. Planers. Early history of the locomotive. Laying out work. Shoes and wedges. Vital points of a locomotive. Pattern making. Clamps and clamping.

The average attendance at the meetings was 21 apprentices. A question box helps to keep up the interest. The questions are read at the meeting and if none of the apprentices are able to answer them they are assigned to be looked up and presented at the next meeting. In August the apprentices held an outing at Bawbeese Lake. During the early part of the season the company cleared a space for a baseball ground. Seven regular games were played.

*Oswego. (H. S. Rauch).*—An apprentice debating club was organized October, 1907, with a membership of 14. It has since grown to include 19 out of the 20 apprentices. Fifteen meetings have been held; until May they were held at intervals of two weeks; since that time and continuing until fall they will be held at intervals of four weeks. The club is organized somewhat along the lines of a fraternal organization, having an initiation ceremony and the following named officers: Master mechanic, general foreman, chief clerk, treasurer and watchman.

The following topics have been considered: Is a locomotive composed of one or two engines? Why do passenger engines have larger wheels than freight engines? Why are shoes and wedges used? Why not solid jaws? When the main crank pin of a locomotive on the right side is on the lower quarter, in what position is the crank pin on the left side? Why are cylinders counter-bored? When laying out counter-bores in a cylinder how do you find the distance between them? How do you find the stroke of an engine? Screws and screw cutting. Illustrating the difference between the Whitworth, or English, standard and the United States standard screw. Square threads and how to grind the tool and set the lathe gears to cut them. Pressure plates—why are they used and how to find their height. Eccentric ring and its use. Care of locomotive boilers. The injector, its use and construction. Laying out shoes and wedges. Lining up guides. How to determine whether or not the driving axles are at right angles with the cylinders. Metallic packing; its use and construction.

A description of the McLaughlin joint was written and illustrated by a first year apprentice and a paper was prepared on "Modern Boiler Construction" by a boiler maker apprentice. Papers were also read on "How to Lay Out and Cut Gears" and "The Proper Method of Admitting Feed Water." An illustrated lecture was given on the Florida East Coast Railway and one of the apprentices gave an extended talk on valve setting, which was continued during ten meetings, the following sub-divisions being considered: Admission, cut-off, expansion, exhaust, compression, lead, inside and outside lap, marking off striking points, etc. This talk was illustrated with lantern slides. The apprentice who gave it made the drawings and these were photographed and made into slides.

At the regular club meetings business is first attended to. This sometimes includes the appointment of a committee to call on a sick apprentice. After this some sort of an entertainment is provided, which may consist of reading magazine articles, recitations or singing. Baseball or other sports, in which the boys are interested, are talked over at the proper time. The projection lantern has been used in connection with almost every meeting. The average attendance at club meetings has been 10.5. The baseball team has played two games with the Depew apprentices, and six games with outside teams.

## Apprentice Clubs.

Benefits, Dangers, Suggestions.

*H. S. Rauch.*—The benefits to be derived from a social, fraternal and educational organization combined are manifold. In the first place a spirit of fraternal feeling is instilled among the apprentices and a chance is given them to state their views on topics that are of common interest. They have an opportunity to listen to the experience of other young men on matters pertaining to their calling; in fact, the club room of our apprentice boys, as it has been handled at Oswego, in a measure takes the place of the college lecture room. Facts which are of vital interest to all young men starting out on a railroad career can be

brought out and explained. Since the organization of the club the boys have written their own papers and given their own talks with no assistance except from the instructor. In doing this it has been necessary for them to study the subject upon which they were to talk. Every opportunity was given them to read up on these topics and information was thereby gained, which they would never have acquired had they not prepared the article for the club.

Another feature of the apprentice club is that there is always a quantity of the latest mechanical literature at hand, which brings them into close contact with the railroad world. The boys learn to feel that they are a part of the great combination, instead of only paid employees, and will often be heard to speak of the railroad with which they are connected as "Our Company," or "Our Road," showing that they have a natural pride in the success of the company. This loyalty is worth more in dollars and cents to the company than is perhaps apparent on the surface. These clubs give the apprentice boy a chance to become acquainted with his superior officers. He learns to know them as they are, and not to look upon them as holding an exalted position, and put there for the express purpose of grinding all the work out of them that he possibly can.

During the past winter Mr. Bradeen, the division superintendent of motive power, was a regular attendant at the club meetings, taking part in the debates. This created a friendly feeling among all concerned, and made us as one big family, each working for the interest of the other and all for the interest of the company.

The dangers from such a club are very small, if properly managed. It is the instructor's duty to attend all meetings of the club when possible, and while I believe that the whole control of the club should be in the hands of the apprentices, and officered by their own men, yet it is sometimes well to exercise a restraining influence over the management. If the instructor has the confidence and good-will of the boys they will ask his advice on all matters pertaining to the club affairs. There might be some danger in a club baseball team becoming a nuisance to the company if the thing is overdone, but with proper care and good judgment on the part of those in charge this can be controled. The boys are benefited in their visits to other shops to play ball, by becoming acquainted with other apprentices and foremen. The ball team illustrates that nothing can succeed without organization and system.

The ways and means of making the club more successful will in a measure have to work themselves out. I do not believe any set rules can govern all clubs, but I do believe that apprentice clubs should be in closer touch with each other than they have been in the past. Anything of special interest in one club should be communicated to the secretaries of other clubs. This will have a tendency to create rivalry, and no good healthy American boy likes to be beaten. Our plan as outlined for the winter is as follows: We expect to have quarters in a company building in the central part of the city; one room is to be fitted up as a reading room, one as a gymnasium and a third as the meeting room. We expect to follow the same lines as last year using our lantern for illustration and entertainments. The boys will write papers on topics assigned to them at the meeting preceding the one at which they are to be read, and as our meetings are two weeks apart there is ample time for preparation. We count on holding a few dancing parties to replenish our treasury, which will enable us, with careful management, to meet each situation as it arises.

*R. M. Brown.*—I believe the greatest benefit from an apprentice club is the experience gained by the boys in holding the different offices and also in getting accustomed to the way meetings of this kind are conducted. The benefits of the club to the apprentice also vary according to the distance he has to travel to reach the club room. In our club about one-half of the regular attendance live in Collinwood, while about four-fifths of the membership live in Cleveland. Many of the boys, after working all day, do not feel like riding eight or ten miles to attend an ordinary club meeting; in fact, many of them do not have the car fare.

The dangers of the organization are comparatively small, although careful watch must be kept to prevent gambling and cigarette smoking and to keep swearing at a minimum. The success of the apprentice club in a place like Collinwood can only be had by having the lowest possible dues, 25 cents per month being too much for some, and by having something especially interesting as often as possible. This we have found to result in lots of hard work on the part of a few.

### Drawing Courses.

Should They Be Lengthened for Slower Boys and Should Brighter Boys Be Allowed to Omit Exercises?

*C. A. Towsley.*—The boy who is naturally bright and quick to grasp ideas and who possesses natural ability for drawing or sketching, will begin with the first sheet and continue to draw each succeeding sheet without requiring very much attention from the instructor. The various sheets lead up so gradually to the point where the boy is required to do some sketching, that practically no difficulty is encountered. For this class of boy I would suggest that a portion of the easier plates which appear occasionally throughout the course, be omitted. He may then more rapidly approach that portion of the course where sketching from machine and locomotive parts is necessary before making the drawing. The work requiring sketches more nearly approaches the work of the shop draftsman and should be given a prominent place in the course. It is especially valuable for those who give evidence of possessing natural ability, or who may be working with the idea of fitting for a draftsman's position.

The slower apprentices, those who are not of a mechanical turn of mind, or who have little natural ability, are up against a proposition when given the first drawing sheet, and require constant watching by the instructor or assistant. These boys generally make poor lines, letters and figures, and are obliged to erase frequently to rectify mistakes. Each succeeding lesson shows little improvement over the first, and when that portion of the course is reached where the boy is to take up sketching and advanced work, he is not fitted for it. In order to bring him up to this point successfully more lessons should be added to the course, so that he can be kept at the work until better qualified. While this arrangement is recommended it would be a difficult matter to decide just what portion should be omitted and what should be added to suit the variety of cases that may develop. My opinion is that the instructor should deal with each case as may best suit the individual.

*G. Kuch, Sr.*—I think that it would not be a good plan to lengthen the time in the drawing courses for slow apprentices, as this would have a tendency to make them slower. A slow boy usually requires more attention than a rapid one, and therefore he should be followed up constantly in order to teach him to work more quickly. If this is not done I find in my experience that slow boys become lazy and sleepy over their work.

I do not think it is encouraging to allow rapid boys to omit exercises. It tends to discourage them and make them lose interest in their work. Experience teaches us that a bright boy, full of ambition, cannot go ahead fast enough; he will soon cover the entire ground without omitting any exercises. A bright boy likes to show how quickly he can work, and the easy grading of the course gives him a good opportunity to do this.

### Teaching by Experiment (Laboratory Work).

*A. W. Martin.*—At the Brightwood school is an experimental or proof corner. After the boys work out their problems on the blackboard they are allowed to go to the corner and prove their work. The problems, which are usually given them, relate to the capacity of air and water pumps and tanks; calculating the leverage and lifting power of hydraulic jacks and pneumatic hoists and problems where areas and pressures are considered. It is our intention to give problems relating to the compressive, shearing and tensile strength of materials. These we could demonstrate on the hydraulic jack accurately enough for all practical purposes.

A good feature in teaching this class of work is that the boy has the actual experience of seeing how the apparatus is constructed, as the lesson sheets require him to give dimensions of various parts, which necessitate taking the machine apart. After doing this he is requested to write an explanation, illustrating it with sketches, of the action of the air or water from the time it enters the pump until it is discharged into the atmosphere or reservoir. When the boy has had this experience we remove some part of the pump, without his knowledge, either leaving it out entirely or replacing it with a defective part. He is then put to work tracing the trouble and is told that he must locate it without taking the pump all apart.

Most of the apparatus used in the corner referred to was scrap, and was put in good shape by the boys during regular class hours. This work included cleaning, repairing, making new parts, assembling, installing and all pipe work. The boys are deeply interested in this work and take considerable pride in what they have accomplished. Thus far we have had no trouble in carrying on this work in the same room with the drawing class.

*A. L. Devine.*—We now have in the school laboratory at West Albany, for demonstrating purposes, the following apparatus: 4½ x 6 in. stationary engine, 22 in. engine lathe, gear rack, Walschaert valve gear model, partial section of 9½ in. air pump, bell ringer, safety valve, indicator and spring balances and sticks for leverage examples. The engine, which is operated by compressed air, runs the lathe by means of pulleys and belts.

Problems have been furnished us for work on the lathe, engine, gear rack, valve gear model and spring balance. These are done during school hours and corrected by the instructor, or one of the advanced boys, before the end of the exercise. Whenever possible we have the boys work in pairs on these problems. This work appeals to the ambitious apprentice, giving him more confidence in himself by working out the problems experimentally, breaks the monotony of the routine work and relieves the instructor to some extent. With an average attendance of thirty boys it is almost impossible for the instructor to devote any time to this class of work, and we have assigned one of the leading boys to take charge of everything but the drawing.

The valve gear model was made in the shop by a cabinet maker assisted by an apprentice; the forgings for the gear rack were made by a blacksmith apprentice and finished by a machinist apprentice. Two machinist apprentices removed quarter sections from several of our larger models to allow for a better view of the interior. With the exception of the valve gear model, all of the above work was done on the boys' own time.

*Discussion.*—At Oswego a machine has been constructed for testing the strength of materials.

### The Use of Sketch Books.

*H. S. Rauch.*—I believe the sketch book to be one of the most valuable acquisitions we have made, for the reason that it teaches the apprentice how easy it is to omit an important dimension, or note, at a time when he cannot go back and get the information without cost to the company. The boys must be made to appreciate the fact that they are expected to get all necessary information when they are making the sketch. As to the proper time to begin sketching, it seems to me that the first model would be too soon. I think that the boys should learn the principles of drawing, the arrangement of views, etc., first. This, of course, will take some boys longer than others, so if the starting point for sketching is fixed we will have to delay it long enough for all to get a fundamental knowledge of mechanical drawing. My experience has been that it takes from ten to twenty-five plates to do this, and sometimes more. I believe that we should begin sketching much sooner than has been the general practice. At Oswego it has been our custom to begin with the seventy-eighth plate, which results in the boys having so much to think of on a "hurry up" sketch that they are liable to overlook many dimensions, whereas if they begin, say on the twentieth plate, the work will be much more simple and they will grow up with it, so that by the time they complete their course, sketching will have become second nature to them.

*G. Kuch, Sr.*—The use of note and sketch books was fully carried out at Depew about one year ago and good results were obtained. Apprentices were requested to sketch parts of engines, etc., draw the plan, side views, elevation and sections and add all necessary dimensions. They could then return to the drawing board and make a complete scale drawing from the sketches.

The use of note and sketch books should be enforced. Apprentices who have passed all examinations and have served six months, should obtain a note book, 2-ft. rule and soft pencil. They should then be required to make sketches and notes wherever possible. The instructor should see that these rules are enforced.

Sketching should not begin with the first model but after the twenty-fifth or thirtieth drawing. Ability to make sketches is a benefit to the company, the boys do not ask so many questions of the foreman and take his time from other important duties.

### Should a Preliminary Sheet of Lettering Be Used?

*C. A. Towsley.*—I would suggest that a preliminary sheet of lettering be introduced into the course and that one sheet at least, and as many more as deemed necessary and advisable by the instructor, be required of each apprentice. Only about one-quarter of the new apprentices are able to do a creditable job of lettering and their ability is usually shown on the first drawing plate. Lettering is a knack that all cannot acquire, even with practice. The other three-quarters would be better off with several hours, or days if necessary, of practice in lettering or until it is evident that they have thoroughly mastered the work.

It is noticeable that a boy who is poor in lettering does not improve as rapidly as in drawing. The reasons are that the amount required is not equal to the amount of drawing, and because lettering is considered drudgery and is distasteful. Nothing detracts more from a drawing than badly formed letters and figures, and for that reason alone, extra precautions should be taken to bring them up to a standard of perfection.

### Study of English.

*Henry Gardner.*—I am thoroughly in favor of the proposition to introduce instruction in the use of English into the fourth year of the apprentice school course.

In practical life the ability to speak and write clearly and effectively is necessary to success. No matter how thoroughly a foreman understands his work, if he is unable to make his men see his methods clearly, he is very much handicapped and cannot have the same hope for advancement which he otherwise would. A mechanic may have an application to make for a change of position or an increase of pay. If he can set forth his demands correctly and concisely, he will be more likely to gain his point than one who cannot. Inspectors and enginehouse foremen are frequently required to make reports to the master mechanic relating to repairs needed on locomotives and cars. A man having the ability to make this report brief, clear and intelligent, to state in good English the necessary information, will add to his chances for promotion.

The instruction in English should include letter writing and composition. I would suggest the following method for instructing boys in letter writing. Begin by requiring each boy to write a short letter upon some common, everyday subject and hand it in for criticism. To make this work more attractive it might be well, at times, to have two or more boys write letters upon the same subject. The instructor should then read the letters aloud to the boys, making a general criticism and comparison. Later, when proficient, it would stimulate interest to have some boys exchange letters and each criticize the letter written by the other.

The instructor should see that letters are written in well chosen, grammatical language, with a logical sequence of ideas, properly paragraphed and punctuated, and above all, each word correctly spelled. He should be careful, however, not to follow too closely the laws of composition. A boy with some origi-

nality may thus be kept from showing it. Teach the boy to say what he thinks without fear of breaking some rule.

The instruction in composition should best be done in the same manner. Common, everyday subjects close to the boy's life and work should be assigned for a short essay. As the boys advance in the work the course may be extended by making the subjects more difficult and increasing the length of the composition.

As with other branches of the school work, a text-book for the study of English would not be satisfactory. Lesson papers giving examples of the most frequently used business letters should be issued to instructors and also lists of subjects for original letters and compositions. Notes to instructors emphasizing the important points to be brought out in correcting the papers would be beneficial.

The time to be devoted to the study of English would depend upon local conditions and the advancement of the boys in the other studies. I do not think it advisable to lead the boys farther than outlined in this paper. Great efficiency in writing good English can only be had after years of practice and study, and it would not be profitable to occupy a large amount of time in such work.

### Home Work.

*A. L. Devine.*—Shortly after the school opened last fall it was found necessary to introduce some system which would encourage the boys to do more home problem work, not only because of the small number of problem sheets handed in, but a majority of the boys were progressing too fast with the drawing. To accomplish this and to provide for a better balance between the problem and drawing work, we made an iron-clad rule that the minimum number of corrected problem sheets handed in must equal one-half the number of drawing sheets completed. At the end of each month we checked the number of problem and drawing sheets, and when not conforming to this rule we put the boys who were behind in problems at the blackboard until they had completed the required number. I may add, however, that we never had occasion to punish any of the boys for being behind in their drawing work, and as soon as they found out that we were in earnest we had very little trouble from the problem work. This arrangement retarded the drawing work but increased the problem output.

We experienced great success by giving the boys a partial answer to all the "A" series of problems. When handing out the problems we attached a blue print giving the answers; each answer having one or two figures blocked out. This gave the boy a clue to the correct solution of the problem. Data sheets are also given out with the problems. This resulted in reducing the number of problem sheets handed back to the boys for correction more than one-half, and the number handed in during the past five months has increased at least twenty-five per cent. I feel safe in saying that nothing has been done for the boys at West Albany, in connection with the problem work, which has been appreciated as much as these partial answers. I believe most of the arithmetics used in our public schools have the answers given to all examples; why not for the apprentices?

### The Car Department General Apprentice.

*L. T. Johnson.*—The applicant must be not less than twenty years old and of an agreeable temperament and good morals. He must have a common school education and a fair knowledge of drafting. The first qualification is a necessity. A boy under twenty is not so able to absorb knowledge and to realize the importance of detail. A good disposition is important because a foreman to be successful must be popular with his men. The education required and the knowledge of drafting are necessary. The need for a good moral character is obvious. These qualifications being fulfilled I would start the boy as a blacksmith helper, keeping him there for six months. His next move would be to go to the machine shop for six months. From the machine he should go to the planing mill for six months, continuing through the various departments, spending at least six months in each. The complete term of general apprenticeship should be three or four years. At the end of this time, after following the prescribed course, the apprentice should be able to hold the position of inspector or assistant foreman.

*R. M. Brown.*—At Collinwood we have general car department apprentices. We take car builder apprentices and put them through the various departments, with the exception of upholstering and such like, for four years. We now have nine apprentices and give them the full course. A year ago we did not have a car builder apprentice.

### The Car Shop Apprentices.

*F. Deyot, Jr.*—The method of instructing the car department apprentices should not differ from that of the locomotive apprentices. The subjects to be treated should not be the same, since the two departments employ men of distinctly different trades. The trades necessary to construct cars are much less difficult to learn than those needed in constructing locomotives. The degree of skill required not being the same, I would suggest that when an apprentice has reached that point in car construction where he can do all classes of work unassisted, that he be transferred to the locomotive department. The locomotive work should be considered a higher grade of study and should be included in his regular course of apprenticeship.

### Shifting Apprentices.

*Frank Nelson.*—From results obtained during the past two years at West Albany, I consider that the best method is to shift the apprentices every three months in both the erecting and machine shops. In this way the boy is given an opportunity to learn all branches of the trade in the shortest time. The accompanying table shows what I would recommend for the four-years' course:

| Time in months. | Wages. | Shop. | Class of Work. |
|---|---|---|---|
| 3 | Prorated with Machinist. | Erecting | Springs, equalizers, brake, etc. General work under engine. |
| 3 | " " | " | Truck work. General repairs. |
| 3 | " " | " | Steam and exhaust pipes, dry pipes, throttle valves, dome caps, etc. |
| 3 | " " | " | Cab work, blow off cocks, injectors, throttles, levers, etc. |
| 3 | Regular rate Day work | " | Boiler work, studs, etc., for new boilers and boilers with new fire boxes. |
| 3 | " " | " | Guides, pistons, valves, steam chests, cylinder heads, main and side rods. |
| 3 | " " | " | Shoes and wedges, binders, etc. |
| 3 | " " | " | Valve setting, keyways, tramming engine, etc. |
| 3 | " " | " | General floor work. |
| 3 | " " | Machine | Bench work, links, rods, levers, etc. |
| 18 | " " | " | Turret lathes, shaper, slotter, planer, boring mill, lathe, air brake or tool room. |

To make this schedule effective at West Albany it would require thirty machines and bench jobs. They must be so arranged that ten boys may be shifted every month, and thus the organization should be such that one boy will follow another right up the line, commencing at bench work and continuing through to the tool gang. If such an organization could be established it would be of great benefit to the boys and would increase the output.

The slow boy should be shifted in the regular routine so that the quicker boy who is to follow him may have the full time allowed upon the machine. A slow boy who does not show decided improvement after three to six days of instruction should be taken off the machine and put on special work for which he is better suited. He should be told that the company cannot afford to reduce the output of the machine. Some boys learn quickly and others slowly. The quick boys often make careless mistakes, while the slow ones, when the idea is grasped, seldom forget it. For this reason every effort should be made to study the dull boy and bring him up to standard before removing him from the machine.

To shift out of turn not only breaks up the organization, but

it is not satisfactory to the boy. Though he may deserve some credit for quickness, if he loses the required number of hours which the schedule calls for on the machine he loses the chance to perfect himself in each branch of the work. A thorough knowledge of one subject is infinitely more valuable than a slight knowledge of many. Another reason why it is not expedient to transfer faster than the regular schedule is that it will create dissatisfaction among the men.

Boys who learn rapidly are kept in view by the foreman and are given opportunities to do a variety of work. The slower boys do not get the wide experience that rapid boys do, although in many cases they work just as hard.

*J. R. Radcliffe.*—If an apprentice is started on bench or floor work he should have all the experience in that line of work that the schedule calls for before he is shifted to the machine. When a boy is started on floor work, and in three months is shifted to a machine, and then is shifted back to floor work in another three months, he has not made as much progress at the end of his first year as he would have had he been kept on floor work until that part of the schedule was completed.

When possible, it is well to have the machines grouped. When a boy is started on a machine, a lathe for example, he is given the simplest work to do. The boy on the machine next to him will be doing a little more difficult work and perhaps the machine will be different. If the boy on the lathe is observing, he will catch on to a good bit of the work done on the next machine, and when it is time to shift him to that machine he will have some idea of the work and will learn faster than if the two machines had been in different parts of the shop.

If a boy has any ambition he will want to be first in his work, just as he would want to be first in his class at school. There are times when a machine run by a machinist is idle. When this occurs it is well to take a bright boy, one who has been on machine work about a year, and put him on the machine. By doing this you not only advance and encourage the boy, but the output of the machine is kept up. Bright boys are often equal to machinists. Slow boys are waked up by seeing others pushed ahead. I do not think that a boy should be held back if he shows unusual proficiency. To advance him will cause others to put forth their best efforts in order to catch up.

*M. T. Nichols.*—We are trying a new method of shifting apprentices in the Elkhart shop, which will do away with a great deal of annoyance to the foremen and loss of time by the apprentice and the machinist with whom he is to work.

When each apprentice to be changed checks in in the morning he receives a card telling him where he is to work and with whom. Should the boy be changed from one job to another in the same department his card reads as follows:

M. J. Donohue—Report to E. U. Dow on guides.
Check No. 98.

In case the machinist is laying off, the apprentice reports to the foreman. If he is to be changed from one department to another his card reads as follows:

Wm. Boardman—Report to C. F. Jacobson, Foreman, for bolt lathe.
Check No. 140.

By using this card the apprentice knows immediately where he is to go and goes to work at once, thus doing away with all visiting or killing time. In the old way, the foreman took an apprentice away from a machinist and sometimes delayed an hour or more before bringing him another boy. During this time the machinist was without help, which might be a serious loss to him if working piecework. The loss to the company is also apparent.

Another difficulty is overcome by the card system of shifting apprentices; under the old method a boy due to go from the machine shop to the erecting shop might be held back by the foreman to finish some job. The erecting shop foreman meanwhile is short one boy, having let him go on the day scheduled for the change. The effect of this is that the erecting shop foreman will refuse to advance a boy until he receives another in his place, thus delaying the boys all along the line. Each foreman will receive a copy of the changes a day or two before they are made. It will be the duty of the shop instructor to check up the apprentices on the morning of the change and see that they are all in their proper places.

### The Relation Between the Instructor and the Apprentice.

The instructor should study the personality and character of each boy and strive to gain his confidence. Every one of the boys is at times going to get the blues and possibly become discouraged, and the instructor's attitude should be such that they will instinctively turn to him for advice and encouragement at such times. That several of the instructors have been especially fortunate in this respect was indicated by the discussion of this question.

### Talks By Company Surgeons.

*C. P. Wilkinson.*—A series of lectures by the company's surgeons would result in much good to the apprentices. The talks should not be given too frequently and should not be too long. I would suggest first taking up the subject of the care of the injured, explaining it so that the boys could understand and remember each rule to be followed. The question might be raised as to whether it would be practical to have the talks during class hours; it would depend somewhat on the surgeon's other engagements. Anything of this nature might better be given after shop hours and to the class as a whole, thus avoiding all interference with shop work. If it is desired to hold lectures during class hours and for all the boys at once, the shop end could no doubt be taken care of.

### The Apprentice Exhibit at Atlantic City.

Mr. Rauch described this exhibit and told of the attention which it attracted and the impression which it evidently made on those who examined it carefully. In closing he said: "The thing that struck me most forcibly was the simplicity of the whole apprentice scheme, the inexpensive equipment, and the broad field from which we can draw models and demonstrating paraphernalia. About all we need is a good, well-filled scrap bin to meet nearly all of our requirements for models used in the drawing class and demonstrating room. Another feature, and a most important one, was the shop work exhibit, which proved beyond a doubt that the inauguration of the shop instructor is an indispensable feature in the apprentice organization. This work, some of which was done by first and second year apprentices, was equal in quality, and in many cases was performed in as short a time, as if done by a skilled mechanic."

### Topical Discussions.

*Should the Question Box Be Introduced Into the School?*—The general opinion was that it should. Boys who are naturally shy will be encouraged to ask questions. The instructor will get a line on troublesome problems which bother the boys and will be better able to help them. It costs nothing to try it. The time to be devoted to the questions could be limited to fifteen minutes, and they should be presented at the beginning of the second hour, when a little diversion from the drawing would be agreeable. The questions should cover all school work, both drawing and mathematics, shop work, locomotive construction and engineering. A question could be read and any member of the class given an opportunity to present his views, after which, if not satisfactory to the instructor, it could be given to some member to look up and present at the next recitation, or could be explained by the instructor.

*Apprentices as Instructors (H. S. Rauch).*—At Oswego we have always had an apprentice for assistant drawing instructor, and the scheme has worked out nicely. When a boy is picked out for an instructor good judgment must be used, as the brightest boys do not always make good instructors. When once selected, the boy must have special training in maintaining discipline, etc. By following this method we have had very good success in using apprentices for instructors.

*Shop Discipline.*—In discussing the question, "Would it be more effective to refer all cases of shop discipline to the superintendent of shops?" the opinion was that only the most aggravated cases should be thus handled and only as a last resort.

*Higher Rates for Boiler Makers and Blacksmith Apprentices.* —The difficulty of securing apprentices in these trades is largely overcome by increasing the rate of pay over that paid to other apprentices.

*Special Courses for Molder Apprentices (C. A. Towsley).*— Great difficulty is experienced in obtaining a boy with a fair education, willing to take up this work, and the result is that out of the four or five apprentices who have started, all have quit or been dismissed.

In a general way the following items might be introduced into our present course, so that it would appeal to the average molder apprentice. Problems dealing with weights of iron, brass, and white metal castings, sand, coke, etc. Estimating weights of castings without and with cores. Estimating weights of castings from patterns, both by weight and cubical contents. Give weights of grades of molding sand, both loose and rammed, dry and wet. Capacity of different size cupolas. Figuring charges for different weights of castings to be poured. Figuring amount of charge for pouring a floor. Charges for different mixtures of iron. Proportions for core sand. Amount of flour for different core mixtures. Ladles of different shapes and sizes, their capacity, etc. Questions relating to use of materials, tools, mixtures and operations, which would be obtained from actual practice.

The drawings should include portions of our present course, which are suitable, together with drawings of solid castings, cored castings, machine and locomotive castings, flasks, ladles, molds and cupolas with charges in place. Sections of various shaped castings in the molds could be drawn.

*The Graduate Apprentice (H. S. Rauch).*—It has been my experience that the graduate apprentice, if given a fair rate of pay, usually sticks to the company. Of ten apprentices who have graduated at Oswego shops within the last two years, nine are now working for the company. Heretofore the apprentice has drifted out of sympathy with his employers by reason of the indifference displayed toward him by those having him in charge. To offset this tendency he must be made to feel that the employers have his welfare at heart, and this can only be accomplished by having not only a good apprentice training system, but the service must be made attractive to him after graduation.

## A TALK TO SHOP SUPERINTENDENTS AND GENERAL FOREMEN.

By Robert Quayle.

(Editor's Note.—*An address on this subject, coming from Mr. Quayle, must carry great force. Although the main repair shops of the Chicago & Northwestern, at Chicago, are between 30 and 40 years old and without many of the improvements which are regarded as essential in modern shop plants, yet it is generally recognized that it is one of the best equipped and organized railroad repair shops in the country. Not only this, but the efficiency of the motive power department, as indicated by the annual reports, is approached by but few other roads. The following extracts have been taken from an extemporaneous address which was made at the opening of the recent convention of the International Railway General Foremen's Association.*)

In your shop repairs you ought to get down, not to what it has cost you, but how does your cost now compare with other roads. Is the cost for repairs on your road 3½ cents a mile, or 4, or 5? If it is 5½ cents a mile on any road in this country, it is too much. It is out of proportion with what other railroads are doing and what they can do and we ought to know these things. I believe that to have an intelligent supervision of work, we must have an intelligent idea of the cost of the work; not only of the supervision so far as the fixed charges are concerned, but of the different processes and methods that this work is going through and what each process is costing, and we want to know whether we cannot introduce some other method that will be very much cheaper and better. The man to-day who builds a little fence around himself and becomes isolated in a large degree and thinks: "This shop of mine over which I have supervision is all right and the set of men that I have about me are the only men, and we are It"—when a man begins to feel that way, he is a back number. The world is making such progress that if we go away for six months or a year and then come back we find we are back numbers. The other fellows who have been in the harness doing the work while we were away have outstripped us in the race. We are making such rapid strides that we have to keep continually at it in order that we may stand a little bit in the front. On the other hand, I do not believe that we ought to be too modest about these things. It is just as bad for a fellow to be too modest as for a fellow who thinks he is accomplishing it all.

### MEN MUST THINK.

The first essential toward the success of a man is for him to think, and think clear down through whatever problem is before him. The man who takes up air brake mechanism must first begin with the atmosphere—the component parts of the atmosphere; he must understand what the pressure of the atmosphere is. He must follow it through the engineer's valve—through the triple valve, and so on; he must take a little wire and trace it from the time it is received into the pump. He must know what the functions of the different pieces of mechanism are and have an intelligent idea so that if anything goes wrong he will know where to look for the trouble; this man is equipped to accomplish something in a moment's time. So it ought to be with you and so it ought to be with me.

You are filling positions because of your alertness—because of your intelligence and because you have shown to the man, who in position is your superior, that you have something in you that the other fellow did not have, and he says, "This is the man we want to promote, because he has qualifications that will make us an efficient man and he has the ability that will help to raise other men up to a higher efficiency." If that be true, you men as superintendents of shops or general foremen ought to get about you men of intelligence—men of rare qualities and ability who will see things and be able to eliminate and cut out all the unnecessary movements that are being made.

You see a man in your shop take a certain piece of work and go from the machine shop to the tin shop—the man has to travel several hundred feet and back. Why not have a little machine do all that cross-head work right where the cross-head is being fitted and save all this going back and forth? These are things that count. Where you have a shop, and have charge of two or three thousand men, as some of you may have, you can readily see that the unnecessary movements of these men amount to a good deal. Your office is to know that these men are not making any more movements than absolutely necessary. It means labor to walk back and forth—it means effort on the part of the men; instead of putting that effort into useless movements, put it into things that count. If you have been advanced to a position because of your intelligence, how much of that intelligence are you imparting to the under fellow? Is it your method to find fault with a man because he isn't doing the work as good as you? You cannot expect that a fellow who is getting $80, $90 or $100 a month to do as much work and to do it as intelligently as the man who is getting $150. He hasn't the same opportunities that you have and it ought to be your business and my business to get these men who are under us (we call them subordinates) in front of us, and have certain stated times to discuss ways and means; your superior intelligence, knowledge and ability ought to, in a very large measure at least, lift these men up into a higher standard of usefulness to you, and when they are working for the company and getting better results they are helping you. Do not find fault with a man because he is not doing a thing, but question him: "Don't you know a better way of doing this?" Do it in a thoughtful manner and get the other fellow to think. What we want to do is to get men to think.

Take premium work and piece work. A man realizes that he is simply a machine—a factor in this world, and his only aim is to accomplish a certain amount of work on certain lines and in

the accomplishment of it he is going to bring to himself larger returns. He begins to study how he can do more of this work with less effort on his part and how he can accomplish more work and bring to himself greater earning power. He begins to think. It is that thought that will better his wage earning power and it is that thought which will lead to your success. How many hours have you put in after you have gone home nights studying how you can improve your men and how you can broaden your views so that you can help yourself? Man is a selfish being, and if for no other reason we ought to study the situation for self. Take the big men of the world to-day. Why are they filling high positions? Is it because somebody boosted them into the positions? Count the men that you know who did not have any more opportunity when they started than you had. Those men have simply come into their positions because, as Shakespeare says, "There is a tide in the affairs of men which, when taken at its flood, leads on to fortune." When the opportunities came they plunged into the tide and went on to success. We were needing a man for promotion, and I mentioned a certain individual to our shop superintendent. He said, "That man can neither read nor write. He stands in his own light." An intelligent man otherwise, who in this generation does not know how to read or write! When he was a young man he ought to have been burning the midnight oil. Gladstone, after he was seventy years of age, mastered the Greek language, and I think there isn't any one in this room to-day who is not able to master higher mathematics.

You have these men about you and you should ask them why they are doing such things so and so. If they are turning off a piston rod, ask them why they do not grind it. Is it possible that in thirty years there has been no improvement in this line? Do not drive it into them in a rough manner, but in an intelligent way, and they won't feel that you are clubbing them. A club over your head don't do you any good and if you have a man who has to have a club over his head, get rid of him. When a man feels that you are driving him, he gets discouraged and don't care; you drive away his usefulness and his interest, and when his interest is gone he is no good to himself or to anybody else. Encouragement ought to be the shop motto. Get every man to do the best he can and to lift himself up to the highest point within the limits of his ability.

### EFFICIENCY.

We have a shop that was built in 1872 and occupied in 1873. The shop, so far as its physical condition is concerned, is no doubt what you would term a back number—the construction of it is such. We have twenty-one available stalls and yet have no trouble in getting sixty-five locomotives in for heavy general repairs, and we can run it to seventy if necessary, and do it economically. The fellow who doesn't get economy will simply have to get down and out, I do not care what his name is.

I note a paper on your program about the different forms of construction of a shop for a transfer table. It is a good thing to think upon these matters so that when you are called upon you may be able to give an opinion; but my duty and your duty more particularly is to do the best we can with the tools and the conveniences that are at our fingers' ends. It does not do for you and me to sit down and talk about what we could do if we had all these facilities, but what we can do and ought to do with the tools that we have.

You will be surprised when you get at the thing right to find what can be accomplished with old methods. We should get busy and study it out. In our shops, Oscar Otto has a plan. Every Monday morning at eleven o'clock he calls his men about him and they go over the work of the past week. He will say, "We ought to have gotten out fifteen engines last week, but I find that we only got out fourteen; something is the matter." A representative of the store department is there and he talks about the material; in discussing the matter, they put the responsibility right where it belongs. The man is there with his associates, and he feels keenly the position, although all remarks are made in a spirit of kindness. The next week it may be some other fellow. Sometimes a delay has been caused by something over which he had no control and the responsibility is passed on to the responsible party. It may have been up to the superintendent of the shops; if so, he is held accountable for the unnecessary delay. It simply strings these fellows up with such a tension that they will next week profit by the failures of last week.

When these men in the shops find that they have failed in certain things, they take a little pride in not having it occur again. I do and you do. It is human nature. It is in every fellow. If he has any respect for himself he wants to do as much and just as well as the other fellow. That is true, and you can do that by getting these men around you and injecting into them the right spirit, and if you haven't the right spirit in yourself, just go away in the woods and hate yourself a few weeks and come back and say, "I am all right." If you are going to get the highest efficiency you must train your men and you must help them. I get my master mechanics about me every once in so often and we talk about various things and they give me lots of information. They hit the old man pretty hard many times, and I say, "Come on. I am here for that purpose." I am not putting on my mittens to defend myself. They just want to hit me a square blow, and the harder they hit me the better I like it, simply because of this fact. What is my position? It is simply a man—a little pivot around whom the organization swings. If the organization cannot accomplish more than the man at the head of it, it isn't a very good organization. The man at the head of it can instill into his men such characteristics as will get at the very best results, and he does it in such a manner as will inspire and instill confidence, and if the men feel that he is a helping friend—that he is a fellow to whom they can go with their troubles—they will be ever ready to assist. Get the men to love you and you will get the men to work for you; they will come to you with all their troubles and then you will begin to eliminate all those things that are wrong. The superintendent of motive power, the master mechanic or the general manager of a railroad who sets himself up on a pedestal so that his men cannot approach him on these matters is a failure. If that applies to the general manager, how much more it applies to you who have the men approach you every day.

### FAITHFUL APPLICATION TO WORK.

You were not the fellows who, when the whistle blew, threw your hammers up in the air; you simply finished what you were doing and did it well. I came here to talk to you just the same as I would talk to the men in our own shop. The motive power men of this country depend upon you and look to you for the men who are going to fill the positions on the railways. You are the fellows who must fill the positions by diligent, faithful, earnest application to the work that you have in hand.

I take great pleasure in the thought that in so far as the motive power is concerned, it is not I, *but the men who are associated with me*, are working with me and assisting me in every way possible to make it a success, and they are helping themselves. If any of you think that the superintendent of motive power is the only fellow, get it out of your heads. He is only a little factor and they get him on their shoulders and they pass him along and keep carrying him along. It is a continual delight to me. Why should not I get around these men and help to lift them up—make them more useful to themselves and their fellowmen? Would I be a man if I did not? If that is true of the superintendents of motive power, isn't it true of you?

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WASTE OF LOCOMOTIVE FUEL.—Coal wastes on railroads are almost as bad as labor and material wastes. On a very large railroad system, fuel charged per 1,000 tons of train weight per mile averaged 260 pounds; yet actual tests, where all coal used was weighed, showed a consumption between terminals of only 80 pounds. This actual consumption could be doubled, be made 160 pounds, yet this standard be only 60 per cent. of the actual wasteful expenditure.—*Harrington Emerson in The Engineering Magazine.*

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The number of miles of railroad per 10,000 inhabitants in the United States, June 30, 1906, was 26.78 as against 26.44 for the previous year.